POWER

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Thomas A. Edison

THE NEWS that the world has awaited for days has arrived. The last page in the life's work of Thomas A. Edison has been written. He has become a part of American history and his work has wrought profound changes in the industrial and social life of millions of people. Interest in Edison and his activities was universal. His principal inventions and achievements bore upon popular usage and affected directly the occupational and domestic habits of whole populations. He actualized the obvious.

That an incandescent filament would not burn in a vacuum or an atmosphere of inert gas, that sound was a vibration that could be recorded and reproduced, was common knowledge. Edison not only knew that these and other things could be done, but did them. He had the imagination to visualize the possibilities, the ingenuity to conceive the means and mechanism for their realization, the dogged persistency to explore all methods and exhaust all resources until an operative solution had been found.

Little of this methodical plodding and patient effort is popularly apparent as essential to the final result. Few of his incidental triumphs over difficulties and subsidiary inventions necessary to the success of his larger achievements are known to the public.

And yet the name of Thomas A. Edison would stand near the head in a composite response to an appeal for a list of the most prominent Americans. It is gratifying that this preferment should be accorded to one whose days have been devoted to the arts of peace and the impress of whose activities has been embodied in industries that conduce to the comfort and well-being of man.

EDITORIALS

Large Diesel Engines

In this number an article by Col. O. F. Allen deals with the development of large diesel engines, in which stress is placed upon the advances made by European builders as contrasted with this country.

When reading this it should not be forgotten that in this country coal is cheaper than oil in many localities, and with modern utility steam plants developing a kilowatt-hour on a pound to a pound and a half of coal, the fuel cost is so low that diesel fuel must sell at around three cents a gallon to attain parity. In the oil fields, where oil is cheap, it happens that natural gas is obtainable at so low a price that the fuel item in large plants is almost negligible.

While large diesels are employed to carry the peak load of European utilities, in this country most systems have excess steam capacity, the peaks being handled by older, less-efficient plants without additional investment.

Consequently, the demand for large diesel engines has been non-existent in this country until the Vernon, California, municipality made its purchase of five six-thousand-kilowatt units. In this case the engines will carry the entire load. Without a demand or a potential market, engine builders abstained from a venture into large unit capacities. They have centered their efforts upon the sizes which have an obvious market, pending events to encourage a forward step.

Reduce Demand Charge On Process Steam

Where power for industrial process is purchased from a utility a part of the cost is "demand charge." The amount of this charge is governed by the ratio of normal average power usage to maximum demand.

The soundness and logic of this charge is well proved, and its acceptance by state rate-regulating authorities as a legitimate part of the cost of furnishing power emphasizes the fact that the existence of such peaks of demand is a source of increased cost.

What is not so apparent is that a similar "demand charge" exists in the costs of both steam and power as supplied from the industrial power plant. Here improvements in the proportion of maximum demand to normal usage for both these services result in definite savings due to lowered investment in plant peak capacity and in better over-all operating efficiency.

Opportunities for reducing total steam requirements within the manufacturing process are numerous by such methods as: the reduction in number of different pressures used, the improvement in utilization within the process equipment through adequate drainage of condensation, and rescheduling of departmental uses so that individual peaks will be staggered. Improvements of this kind will all be reflected in the loading of the steam plant, its required capacity and its cost of operation.

Thus industrial management, when faced with the problem of replacing or expanding the process steam and power facilities, should start with a careful and comprehensive study of the usage rate and extent of these services, as well as their application to the manufacturing process. Such a study, if accurate and unbiased, will not only guide executive decision in the economical development of the required services, but may point the way to material savings in operating and investment costs.

Ionization May Alter Ventilating Methods

Ventilation authorities have recognized for many years that air in occupied rooms, even though temperature and humidity are controlled, lacks the stimulating quality that fresh outside air possesses. Recent researches at the Harvard School of Public Health sponsored by the A.S.H.V.E. seem to indicate that the ionic content of the air may be the vital principle that is lost when fresh air is brought into an occupied room.

Air contains positive and negative ions which may be small or large in size. It has been found that when a room is occupied the number of small negative and positive ions in the air within it decreases rapidly, and to maintain an ionic content equal to that of outdoor air, 160 cubic feet of fresh air per minute per person must be supplied. This is more than five times the quantity of air generally used for ventilation.

The ionic content is influenced by the method of air conditioning. Washing or cooling decreases the negative and positive ions, while heating increases them. The next step in the research is to determine what effect the ionic content of air has upon health. Radical changes in ventilation methods may be looked for if the suspected influences are established.

The Door Is Open

This issue finds *Power* in its new home — the McGraw - Hill Building, 330 West Forty - Second Street, New York City. Our editorial offices are on the thirtieth floor, with an impressive view of mid-town and upper Manhattan.

When power engineers come to New York, they are likely to see a bit of Broadway in the neighborhood of Times Square. Less than two blocks away is the new building, where *Power* editors will welcome any reader who may feel the urge to pay them a visit.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

DETROIT EDISON HAS COMPLETED ITS

High-Temperature Installation

By R. M. VAN DUZER, Jr.
Technical Engineer
Detroit Edison Company

READERS of *Power* who have followed the high-temperature experiment of The Detroit Edison Company will be interested to know that the permanent installation of equipment at the Delray Plant is now complete and operating with steam above 700 deg. F. Previous announcement regarding the details of the whole installation has not been made because of delays encountered in the fabrication of the superheating equipment. The British Thomson-Houston turbine-generator, however, was placed in service last October, with a temporary line supplying station steam for preliminary operation. Between that date and April of this year, the machine carried load for 655 hours with frequent shutdowns for inspection and minor adjustments. During April, the high-pressure cylinder of the turbine was dismantled for inspection and installation of new diaphragms, preparatory to the installation of the permanent piping and superheater. The equipment was again placed in service the early part of July, and since then the steam temperature at the turbine throttle has been raised in steps to 850 deg. F. at this writing, without any operating difficulties.

Briefly the reason for the installation of the equipment now operating at Delray[1] was to add to present knowledge of the behavior of alloy steels subjected to steam temperatures higher than are now in common use in central stations, thereby increasing the range of the straight regenerative turbine cycle.

Preliminary Installation at Trenton Channel

As a preliminary step in the design of the Delray apparatus, a small superheater, with a piping system at its outlet, was installed at Trenton Channel to supply steam at 1,100 deg. F., as it was realized at that time that some difficulties would occur in the contemplated complete installation. Experience gained from this small superheater did prove valuable, particularly in the design of the Delray piping.

The pipe joints installed at Trenton Channel was provided with 600 W.S.P. American Standard flanges and bolts which proved to be too weak for the service. Joint failure was caused by stretching of the bolts owing to the stresses imposed by the temperature differential between the pipe and the outer portion of the flange. This temperature difference was as high as 100 deg. F., notwithstanding the fact that the outside of the joint covering was not over 125 degrees. Several of the original joints were replaced with joints having heavier flanges and bolts which to date have given no trouble owing to the materially decreased working stresses.

As a result the Delray pipe joints were designed with heavier flanges than were originally installed at Trenton Channel. Several different types of construction also were selected in order to add to the knowledge of joint behavior at high temperatures.

A desuperheater casting of Resiztal, an 18-8 chromium, nickel alloy, which failed in service after 6,400 hours of use, was found to be full of cooling cracks and inclusions which, eventually, would have caused failure at ordinary steam temperatures. This failure was not considered to be indicative of the effect of high temperatures, but rather was due to the faulty condition of the casting as originally received. A section of pipe made from the same type of alloy and removed at the same time showed only a slight reduction in physical properties.

Some indication of the limitation in the use of calorized material was gained by the addition of a superheater section superimposed on the outlet of the original apparatus. Tubes which were subjected to flame impingement in the combustion chamber were oxidized badly, while other parts of the unit that were exposed only to the high-temperature steam were still in good condition after approximately 4,000 hours of service. This type of protective coating appears to have use up

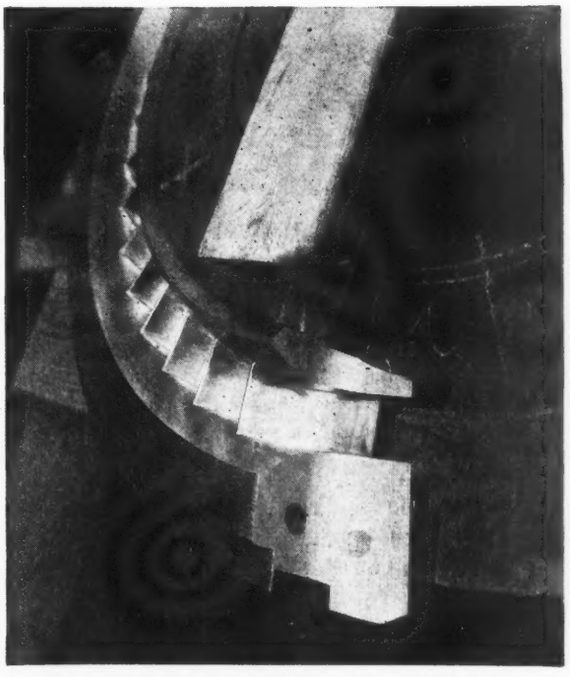

Fig. 1—Blades on bottom half of second stage diaphragm, inlet side, of high-pressure turbine

[1]See "1,000 Deg. Turbine for Delray No. 3," by J. W. Parker, *Power*, May 28, 1929.

to rather high temperatures, even if not up to the extreme temperatures to which these tubes were exposed.

At Delray the equipment installed consists of a 10,000-kw. turbine-generator with its condenser and auxiliaries and an oil-fired superheater, together with the interconnecting piping. The superheater contains 3,957 sq.ft. of heating surface and has been designed to raise the temperature of 90,000 lb. of steam per hour from 700 to 1,100 deg. F. at a maximum working pressure of 455 lb. gage. Referring to the front and side elevations shown in Figs. 3 and 4, it can be noticed that the superheater is composed of three separate sections: the top convection section, the middle combined radiant-convection section, and the bottom radiant section, all of which are connected in series.

The top section was made from low carbon-steel tubes rolled at both the inlet and outlet headers. The steam temperature is increased from 700 to 850 deg. F. in this section at full steam flow and 1,100 deg. at the outlet. The middle section has been made from alloy steels exclusively, the analyses of which are given in Table II. All tubes were sealed by welding inside and out, and the hand-hole covers were welded in place. The steam temperature is raised to 1,033 degrees.

For the bottom section the same alloys are used. Pairs of adjacent tubes were welded in small forged headers which in turn were connected to the inlet and outlet headers with short threaded nipples welded in place. This method of attachment resembles the bifurcated construction sometimes used in boiler and superheater construction. Hand holes were eliminated in the headers in this section because of the possibility of leaks. Small refractory tiles, shown in Fig. 5, were cemented to the tubes and held in place by welded lugs to protect the tube from excessive temperatures. Steam leaves this section of the superheater at 1,100 degrees.

The particular analysis of 18-8 chromium nickel alloy used for the tubes in the lower sections of the superheater was recommended by the manufacturer to reduce the danger of tube failure from sulphur corrosion, as such a corrosive attack has been responsible for failures of the 18-8 alloy in oil refinery practice. The 2 to 2.5 per cent addition of silicon increases the resistance of the alloy to sulphur corrosion approximately ten times. Fuel oil with a sulphur content below 0.75 of 1 per cent is being used to further avoid the destructive action of flue gases on the tube material.

Difficulty in fabricating this alloy into tubes caused considerable delay in the completion of the superheater. Tubes of this material had been made successfully in small quantities, but it proved to be quite another matter to produce the number and the long lengths required for the Delray unit. Longitudinal cracks also appearing in the tubes during bending added to the delays and difficulties.

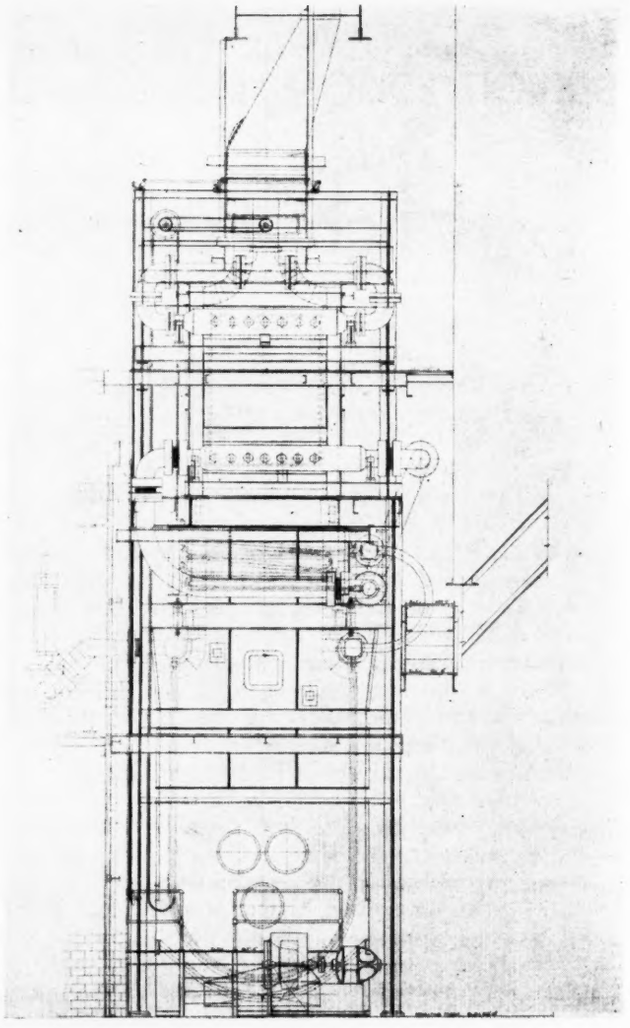

Fig. 3—Front elevation of superheater

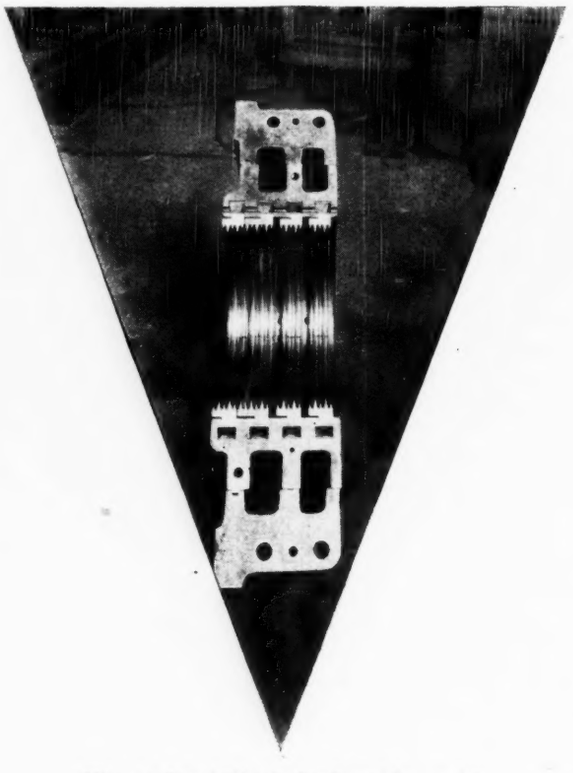

Fig. 2—Top half of gland packing, outer box, exhaust end of low-pressure turbine

On the other hand, the alloy forgings and castings used throughout the superheater were made from the straight 18-8 composition, the analyses also being given in Table II.

Several of the alloy tube sections in the intermediate section were replaced with two groups of 0.30-0.40 C tubes. One set of tubes was calorized and the other group had a protective coating of 18-8 alloy which was applied with a Schoop metal spray gun. Accurate measurements were taken at several points on each of these special tubes before they were placed in service. These measurements will be repeated at frequent inter-

vals to indicate the amount of creep, and a record will be kept of the behavior of the protective coatings.

The superheater is single-pass with no "heat traps" at the outlet. Should the design flue gas temperature of 850 deg. F. at the outlet cause too rapid deterioration of the unlined steel stack, air admission doors, provided at the base of the stack, can be opened to lower this temperature.

A forced-draft fan is required to supply the quantity of air needed at the maximum combustion rate. However, no induced-draft fan is necessary, as the stack provides sufficient natural draft. The air supply to the burners is furnished through a double front in the wall and the quantity is regulated either by a damper located in the discharge of the fan or by the dampers installed in the burner housings.

Uniform combustion conditions will be obtained by the use of a Bailey air-flow steam-flow meter, which as yet has not been placed in operation owing to the low combustion rates at which the burners have been operated. An average CO_2 content in the flue gas of 11 to 12 per cent will be carried when normal operation of the equipment is established. A higher CO_2 content will not be desired because of the higher furnace temperatures that would result.

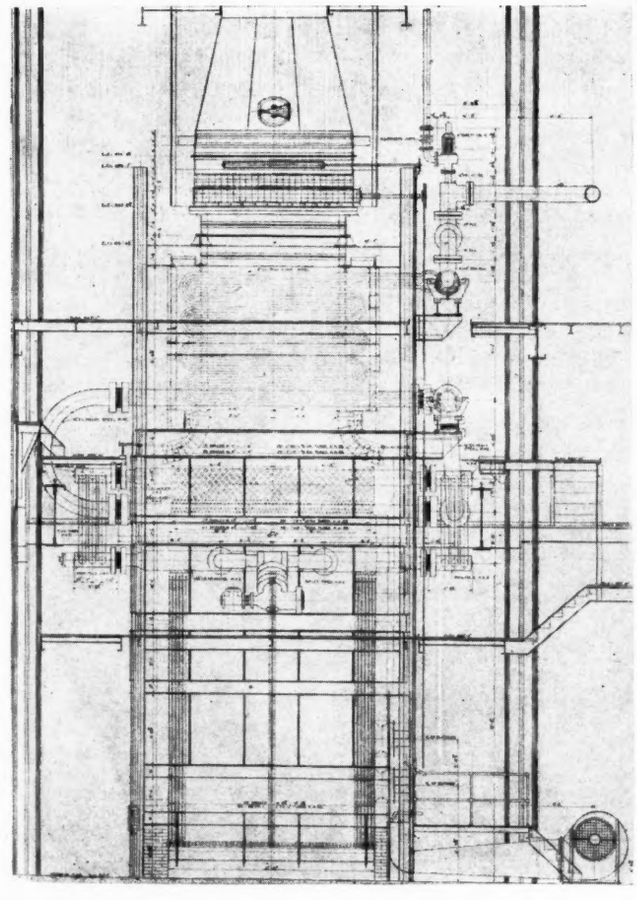

Fig. 4—Side elevation of superheater

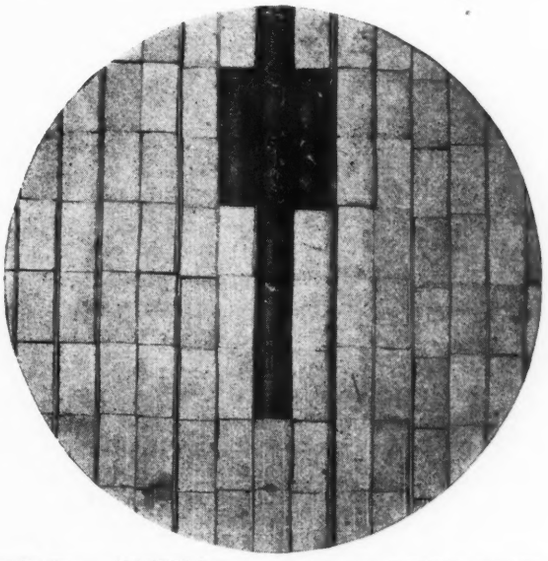

Fig. 5 — Radiant section of superheater showing refractory on tubes, and location for thermocouples

The superheater has been equipped with three oil burners of the mechanical atomizing type which are capable of burning 2,100 lb. of oil per hour when supplied with oil at 300 lb. per square inch. The amount of oil burned is regulated by varying its pressure or by changing the size of the atomizing nozzle.

A No. 6 industrial fuel oil is being fired which has a sulphur content below 0.75 of 1 per cent. Two 12,500-gal. tanks located in an underground pit provide storage. Oil is taken from the storage tanks by either of two Quimby screw pumps and is pumped through a closed type steam heater to the burners. Excess oil is returned to the suction of the fuel pump through a relief valve. The oil temperature is regulated automatically by a thermostat controlling the steam flow to the oil heater. Owing to the heavy grade of fuel oil being used, adequate provision has been made for heating the storage tanks and oil lines during cold weather.

Provisions for cleaning the superheater tubes while the unit is in service were not made for two reasons: first, because of the nature of the fuel which with proper combustion will cause only slight dirt deposit, and second, because of the expense of maintaining soot-blowing elements in the hotter portions.

Thermocouples have been provided at a number of points throughout the various parts of the superheater. Those located on the tubes in the lower section of the unit have proved to be invaluable in placing the superheater in service, while those located in the other parts will be used to check the superheater performance.

In starting up the superheater, the lower section fills with water which must be completely evaporated before steam can be admitted into the turbine. It was thought before the superheater was placed in service that the quantity of steam bled from the outlet would be sufficient to heat up the tubes and tile without the use of a fire. This was not the case, and now, after experience with the equipment, the starting cycle consists of lighting one burner about an hour before steam is admitted, to thoroughly heat up the lower section. After admitting steam, the tube temperatures in the lower section are raised well above the saturation temperature before any steam is admitted to the steam chest of the turbine. Temperatures of the tubes in the intermediate section which are directly exposed to the radiant heat have not been above 1,000 deg. at any starting period.

Some trouble has been experienced with loosening of the small protecting tile in the lower section. The tiles that have come off so far indicate that the cement was improperly applied, as those that have been recemented cannot be removed except by breaking. This type of tube protection has given no trouble at Trenton Channel.

Provision has been made to prevent overheating of the

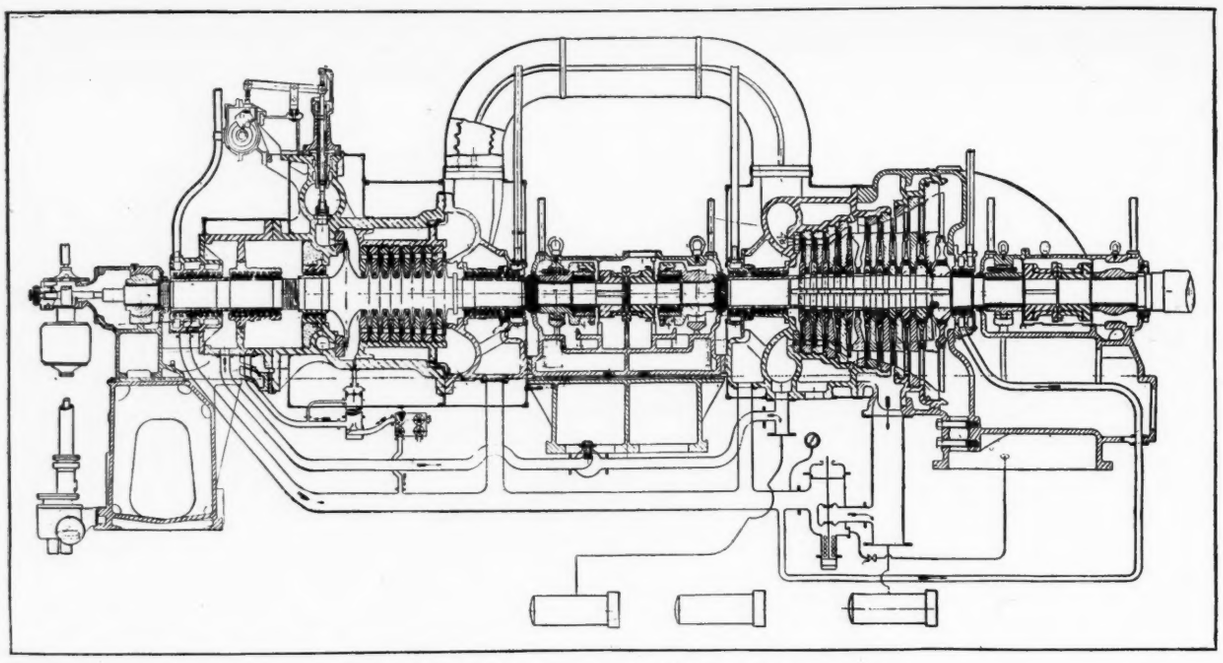

Fig. 6—Cross-section through 10,000-kw. turbine-generator

tubes in case the machine is tripped because of an emergency condition. A solenoid-operated relief valve of the safety-valve type has been provided at the outlet of the superheater, which will open whenever the throttle valve is tripped by the overspeed tripping mechanism. The motors driving the fuel oil pumps are stopped at the same time the relief valve is opened, thereby preventing the addition of more heat to the setting. The relief valve will remain open as long as it is necessary to allow cooling steam to flow through the superheater. Also it may be opened and closed independent of the position of the throttle valve by a manually operated switch.

The High-Temperature Turbine

A cross-section of the high-temperature turbine is shown in Fig. 6. This unit is a two-cylinder tandem-compound machine with impulse blading and steam extraction for feed-water heating at three points. Steam conditions at the throttle are 365 lb. gage, and 1,000 deg. F. total temperature, while the exhaust condition will be 1 in. hg., abs., with slightly less than 10 per cent moisture in the steam.

Rated at 12,500 kva. at 0.80 p.f. the generator at 3,600 r.p.m. will deliver power at 60 cycles and 4,800 volts. Specifications of the turbine, the generator and the auxiliaries are given in Table I. A more detailed description of the turbine is appearing elsewhere in the technical press.[2] However, some of the interesting features of the design have not as yet been described.

New diaphragms just installed in the high-pressure cylinder were supplied by the turbine builders to replace the original diaphragms which were not thought satisfactory for the high-temperature service. The latter were supplied with the turbine for preliminary running rather than hold up delivery of the machine. The new diaphragms were fabricated from forged alloy steel parts which were pinned and welded together in contrast to the original cast diaphragms. Fig. 1 shows the bottom half of one of the new diaphragms. With the type of construction used in the assembly, it was possible to polish all of the smaller nozzles before they were fixed in place, an operation which is greatly hampered by the close clearances in the conventional cast type. This refinement in the nozzles will slightly reduce the friction loss through the high-pressure cylinder.

The shaft packing used throughout the high- and low-pressure cylinders is of the saw-tooth design, sections of which have high and low teeth, while the remainder have teeth of even dimensions. The packing is composed of individual rings, each ring of which is made in four sectors. Each sector is backed up with a leaf spring.

Initially, the packing is installed to touch or ride on the shaft and then clearance is established by running the turbine at low speed for several days. The leaf springs provide enough flexibility so that the packing is not damaged during starting periods when a slight shaft deflection may be present. It will be quite a simple matter to repair this type of packing by remachining the worn teeth and refitting the individual sectors. A section of the high-and-low-tooth type is shown in Fig. 2.

Cross-over pipes connecting the high- and low-pressure cylinders have been made from corrugated pipe to allow for expansion of the high-pressure cylinder without imposing undue thrusts on the turbine casing. Some of this same type of piping has been in service, supplying steam to a 50,000-kw. turbine at Marysville for nearly

TABLE I — PHYSICAL DATA OF TURBINE-GENERATOR AND AUXILIARIES

Turbine-Curtis, 2-cylinder, tandem-compound, 20 stages; extraction, 3 stages — 9th, 14th and 17th; steam conditions — 365 lb., gage, 1,000 deg. F. total temperature, exhaust 1 in. Hg., abs.; speed, 3,600 r.p.m	British Thomson-Houston Co.
Generator — 12,500 kva. at 0.80 p.f.; 3 ph., 60 cycles, 4800 v.; excitation, direct connected; ventilation, closed system; speed 3,600 r.p.m.	British Thomson-Houston Co.
Condenser — 2-pass surface, 8,000 sq.ft.; tube material, 70–30 brass; tube size, 1 in. o.d., 18 B.W.G.	Worthington Pump & Mach. Corp.
Generator air cooler — Fintube type, 27,000 c.f.m. from 150 to 96 deg. F.	General Electric Co.
Pumps, hot well — Two 2-stage, 200 g.p.m.; disch. hd. 140 ft. at 1,750 r.p.m.	DeLavalSteam Turbine Co.
Motors, 20-hp., 240-v., d.c., 1,750 r.p.m.	General Electric Co.
Pump, boiler feed — One 6-stage, 200 g.p.m.; disch. hd. 1,340 ft. at 1,800 r.p.m.	DeLaval Steam Turbine Co
Motor, 150-hp., 240-v., d.c., 1,800-1,520 r.p.m.	General Electric Co.
Pump, heater drain — One 2-stage, 50 g.p.m., hd. 150 ft.	Worthington Pump & Mach. Corp
Motor, 5-hp., 240-v., d.c., 1,750 r.p.m.	General Electric Co.
Pump, dry vacuum — One 2-stage 21 x 14-in. rotative, horizontal, 125 r.p.m.	Worthington Pump & Mach. Corp.
Motor, 25-hp., 240-v., d.c., 60-125 r.p.m.	General Electric Co.
Pump, circulating water — One 20-in. volute, 10,000 g.p.m., hd. 19 ft., 435 r.p.m.	Worthington Pump & Mach. Corp.
Motor, 60-hp., 240-v., d.c., 215-435 r.p.m.	General Electric Co.
Heaters, extraction — Three 4-pass condenser type, 84,000 lb. per hour	Griscom Russell Co.

[2]See *Electrical World*, Oct. 24, 1931.

a year with no indication of joint trouble or corrosion owing to water collecting in the corrugations during periods of shutdown.[3] English turbine builders and the British Admiralty have made extensive use of this piping for several years with marked success.

Design of the throttle valve and the manner in which it is tripped differs somewhat from American practice. An oil-operated piston connected to the lower end of the valve stem causes the valve to close whenever the overspeed trip relieves the oil pressure from the bottom of the piston. To open the valve with the handwheel, it is necessary to have the piston in its top position, firmly seated against a seat ring provided at the top of the cylinder, and full oil pressure under the piston. The piston, in this position, takes the thrust required to open first the small internal bypass and then the main spool. Release of pressure under the piston allows a heavy coiled spring to force the piston downward until the main spool and bypass are closed. The valve cannot be reopened until the piston is again seated against the top of the cylinder with the oil pressure reestablished. Oil escapes past the piston in any intermediate position, so that it cannot take any thrust except in the reset or top position.

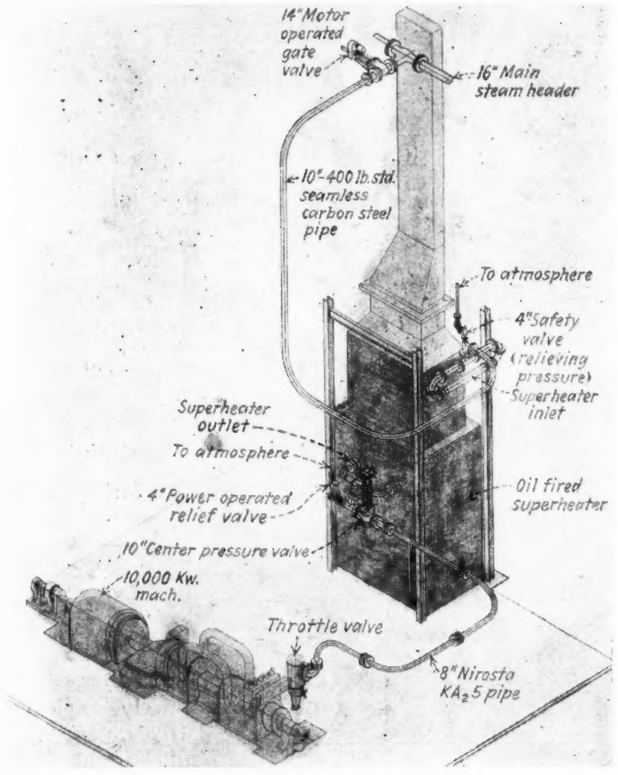

Fig. 7—Isometric of superheater and turbine unit, showing piping layout

Piping connecting the superheater and turbine is not extensive, as less than 50 ft. of tubing was required.[4] However, much thought was given to the design and the selection of materials that were used for the various parts. Fig. 7 shows the layout. Steam is led from the superheater through fittings cast from 18-8 chromium nickel steel. At one end of the reducing tee is located the solenoid-operated relief valve which discharges through a vent to the roof, while adjacent to the other end is a 10-in. center pressure valve.

The 8-in. tubing of low carbon 18-8 alloy which is connected to the valve with a reducer, will be subjected to a maximum combined stress of 6,240 lb. per sq.in. at 1,000 degrees. Plastic flow or creep of the pipe material was neglected in determining the combined maximum stress caused by thermal expansion and internal pressure, because the stress, which exists immediately after the pipe reaches the operating temperature, is the controlling stress. Careful measurements will be made to determine just how much the pipe line tends to relieve the thermal stress by creep.

Dimensions of the flange and fittings conform in general to the 900 W.S.P. American Standard. There are exceptions, however, in the case of the outlet fittings which have thicker flanges, the 10-in. valve whose dimensions conform to the 600 lb. American Standard, and the turbine throttle valve flanges which have a larger bolt circle diameter.

Operation of the unit to date with 900-deg. steam has not resulted in any difficulties, and it seems unlikely that any unsurmountable problems will arise. The temperature has been increased in steps of 50 deg..

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[3]See A.S.M.E. paper, "Load Deflection Relations for Large, Plain, Corrugated and Creased Pipe Bends," by E. T. Cope and E. A. Wert, June, 1931.

[4]"Piping for 1,000-Deg. Steam," by J. H. Walker in April, 1931, *Heating, Piping and Air Conditioning.*

TABLE II— CHEMICAL AND PHYSICAL PROPERTIES OF SPECIAL STEELS USED IN HIGH TEMPERATURE INSTALLATION

	Chemical Analysis, Per Cent by Weight								Physical Properties				
Name of Part	C	Cr	Ni	Mo	W	Mn Max.	Si	P&S Max.	Tensile Strength, Lb. per Sq.In.	Yield Point Lb. per Sq.In.	Elongation Per Cent in 2 In.	Reduction of Area, Per Cent	Remarks
SUPERHEATER—THE BABCOCK & WILCOX CO.													
Carbon steel tubes and headers.	In accordance with A.S.M.E. Boiler Code												
Alloy steel tubes in middle and lower sections	0.10–0.20	17.0–19.5	8.0–10.0	....	.....	0.65	2.0–2.5	0.025	90,000	35,000	40	40	Known as KA 2 B
Headers — middle and lower sections	0.16–Max.	17.0–20.0	8.0–10.0	....	....	0.50	0.25–0.75	0.025	85,000	25,000	40	40	Known as KA 2
Castings — Outlet fittings	0.25–Max.	17.0–20.0	8.0–10.0	....	....	0.50	0.25–0.75	0.030	70,000	30,000	40	40	Known as KA 2
TURBINE—THE BRITISH THOMSON CO. LTD.													
Castings in hp. cylinder subject to high temperature	0.31	0.35	3.10	0.34	.....	0.72	0.32	0.06	137,000	118,000	26 in 1'	33	These specific properties typical of various casitngs and other parts of turbine
Forged rotor	0.43	0.78	3.21	0.54	.....	0.53	0.18	0.016	151,000	143,000	20	35	.....
Blading — 1st stage	0.47	11.84	36.32	....	.....	0.24	0.23	0.01	.....	Not available	..	..	.....
Blading — All buckets and nozzles other than 1st stage.	0.25	14.28	0.28	....	.....	0.52	0.34	0.015	96,000 to 124,000	59,000 to 93,000	27–37	60–69	.....
Bolts and studs	0.48	1.28	2.59	0.59	.....	0.62	0.15	0.02	124,000	103,000	26	61	.....
Nuts	0.43	8.50	.....	....	.....	0.60	3.50	.....	164,000	139,000	20	44	.....
PIPING													
8-in. tubing	0.07–Max.	17.0–19.0	8.0–10.5	.....	.....	0.50	0.025	0.025	84,000	38,500	69	65	Known as KA 2 S
10-in. valve	.....	Not divulged by Hatfields, Ltd.							67,000	40,000	31	45	.....
Reducer	0.25	.....	.....	0.50	.....	.....	.....	0.05	78,000	45,000	25	40	Analysis suggested by R. W. Bailey
Reducing ell and relief valve	0.15–0.22	5.0–6.0	.....	0.50 Max.	0.80–1.25	.....	0.50	0.05	120,000	100,000	18	50	Analysis suggested by V. T. Malcolm
Loose flanges	0.35–0.45	0.90–1.25	1.50–2.00	....	.....	0.30–0.60	.....	0.045	100,000	65,000	18	30	SAE 3240 — Analysis suggested by Prof. A. E. White
Bolts	0.45–0.50	1.20–1.40	.....	....	1.75–2.25	0.20–0.35	.....	0.045	200,000	185,000	12	45	"Seminole Hard" Nuts of same steel unheat treated

THE LARGE OIL ENGINE FOR CENTRAL STATION SERVICE

By OLIVER F. ALLEN
Consulting Engineer, New York City

Recent purchase of five 7,000-hp. double-acting two-cycle diesel engines for the Vernon, Cal., municipal plant is not a venture upon unplotted seas of diesel design. These engines embrace well proven features and represent the modern stage in the long period of development which started with Dr. Diesel's first crude machine.

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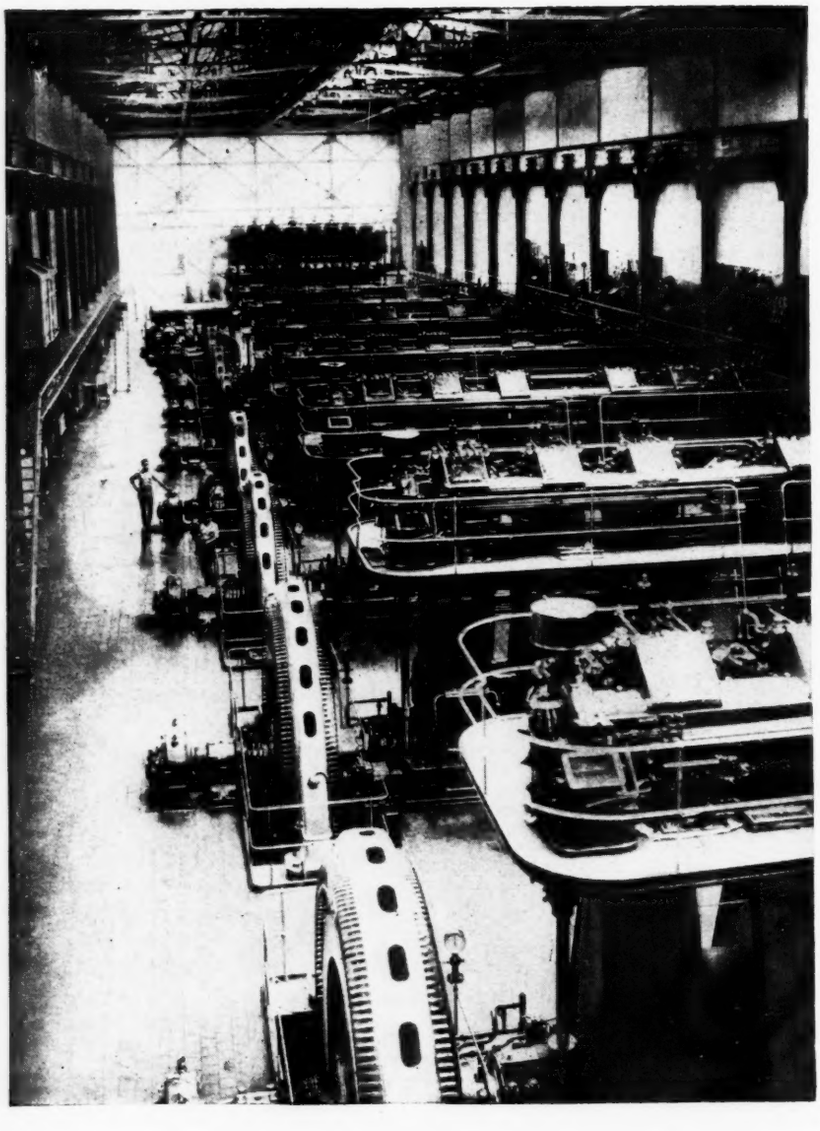
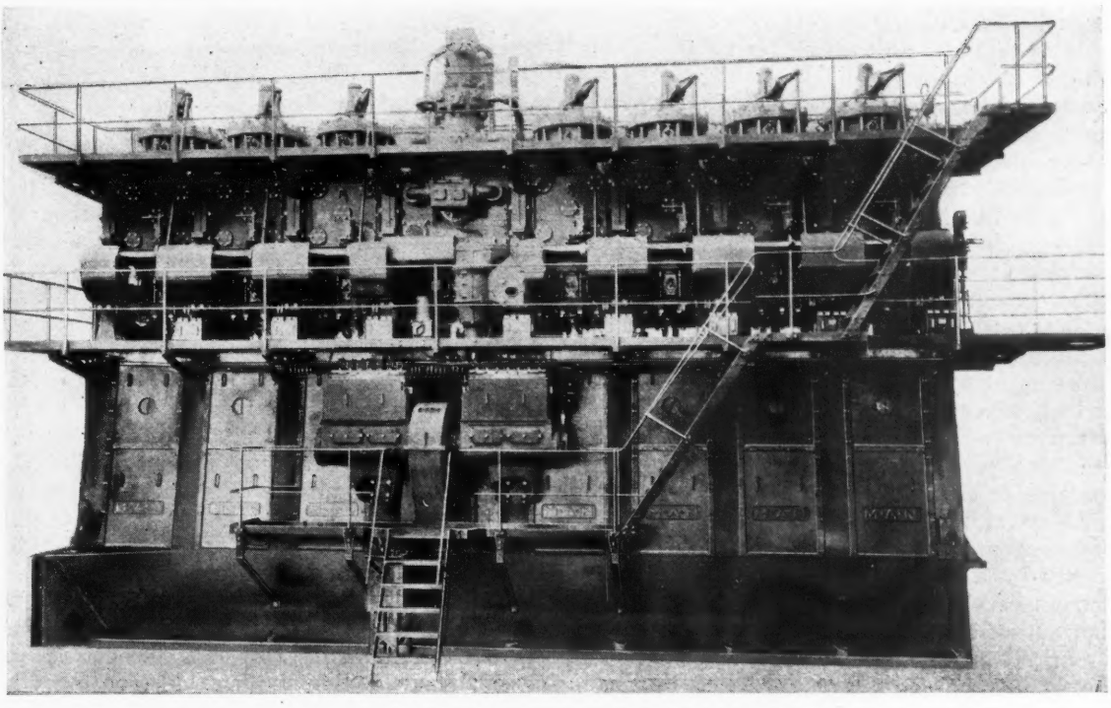
The Maria Elen, Tocopilla, Chile, Nitrate power plant contains 21,000 hp. of German diesels, including a 5,600-hp. double-acting unit



THE internal-combustion engine started as a purely explosive motor about 250 years ago with the Abbe d'Hautefeuille's gunpowder engine. The gas engine proper is about a hundred years old and the commercial internal - combustion engine may be said to have started with Otto and Langen at Cologne in 1867. As an indication of the growth of interest in internal-combustion engines in the United States, it may be noted that United States patents for gas, gasoline and oil engines began with three in 1875, reached 50 per year in 1889, and averaged about 80 per year until 1902 when the total passed 1,400. By that time Westinghouse was building 3-cylinder 650-hp. vertical gas engines and several other American manufacturers, notably Nash, Otto and Foos, were supplying gas engines with direct-connected generators in sizes between 100 and 200 hp. Most of these engines burned natural gas, illuminating gas or unenriched water gas. There were a few relatively large producer-gas plants. In the natural-gas fields a great many en-



A 5,600-hp. M.A.N. two-cycle double-acting diesel, similar in design to the 7,000 hp. units sold by Hooven-Owens-Reutschler Company to the City of Vernon, Calif.

gines, most of them of smaller size, built by various firms, were used in a variety of services including pumping and electrical supply. There were at this time a number of central stations, both municipal and privately owned, whose main, if not entire, source of power was from gas engines. These stations were well scattered over the United States and while few, if any, of them exceeded 1,000-hp. capacity, and most of them were less than half that size, they were relatively as important compared with the steam plants of their day, as the large oil engine installations are today, compared with the steam-turbine plants.

The use of blast furnace and other byproduct gases of low thermal value was studied quite early and many of the features found in the modern large diesels were incorporated in the early blast-furnace gas engines. Perhaps the most important of these was the double-acting cylinder which has only recently been generally applied to oil engines. The large horizontal gas-engine development had reached such proportions by the outbreak of the World War that there were many engines of 3,000 to 5,000 hp. in service and at least one engine built by Cockerill in Belgium was of 12,000 hp. When one realizes that there is more than a generation of gas-engine development behind the large double-acting diesels, it becomes apparent that the large central station oil engine is not so much of an experiment after all.

The first practical diesel motor was operated early in 1897 by the Maschinenfabrik Augsburg, which is now the principal works of the M.A.N. This has been preceded by five years of experimental work at Augsburg; at the Carels plant in Ghent, Belgium, which built its first engine in 1894, and by Sulzer in Switzerland where the first Sulzer diesel was produced in 1896. The first American diesel, a 60-hp., 2-cylinder engine, was completed by the predecessor of Busch-Sulzer in September, 1898. At an exhibition in Liege, Belgium, in 1905, a 500-b.hp., 3-cylinder Carels engine was shown direct connected to a generator. This is believed to have been the largest diesel built up to that time and marks the beginning of the manufacture of central station units comparable with steam units.

During the next few years, up to the outbreak of the World War, the use of diesels for central stations, both municipal and privately owned, extended rapidly in Europe and in European-owned utility plants in South America, India and elsewhere. There were a few central station installations in the United States, but generally speaking, the oil engine did not begin to supersede gas and steam engines here until later. The largest before-the-war installation in England was the central pumping plant of the Gladstone Dock at Liverpool, consisting of five 1,000-b.hp., 4-cylinder, two-cycle Carels engines. The first large diesels to go into service in the United States were two 1,150-b.hp. Carels imported in 1913 by the Phelps Dodge Corporation.

Before 1918 several European manufacturers had built 1,000-hp., single-acting cylinders, but the largest cylinders in regular commercial service were of the order of 500 hp. each, these being two-cycle, which meant with 6 cylinders, the greatest number then considered feasible, a maximum output of about 3,000 hp. In other words, the largest oil engine of that period was still considerably smaller than the largest gas engine and was one-tenth of the size of the largest steam engine.

Immediately after the armistice the demand for larger prime movers became insistent and resulted in the growth of the steam turbine up to more than 200,000 hp. per unit, with the practical elimination of the reciprocating steam engine for central station service and the growth of the oil engine to over 20,000-hp. units. Meanwhile the gas engine for blast-furnace, pipe-line and similar work has considerably increased in the number and horsepower of installations, but the diesel has practically eliminated the gas engine in the central station field and has kept the same relative position of approximately 10 per cent of maximum unit output in relation to steam turbines.

At the beginning of the post-war developments, reduction in weight, increase in rotative speed and greater

output per cylinder and per engine, were all studied simultaneously. The result has been remarkable. Although these developments did not really get under way until 10 years ago, within that period weights per horsepower of diesels for central stations have been reduced more than half, rotative speeds have been doubled, and output per cylinder and per engine increased four to five times.

Part of this has been the result of applying the double-acting principle to the diesel motor. Single cylinders of over 2,000 hp. were built experimentally at the beginning of this post-war period and have resulted in several types of practical commercial engines of between 1,000 and 1,500 hp. per cylinder and one central station unit is now being built which will have an output of 2,750 hp. per cylinder.

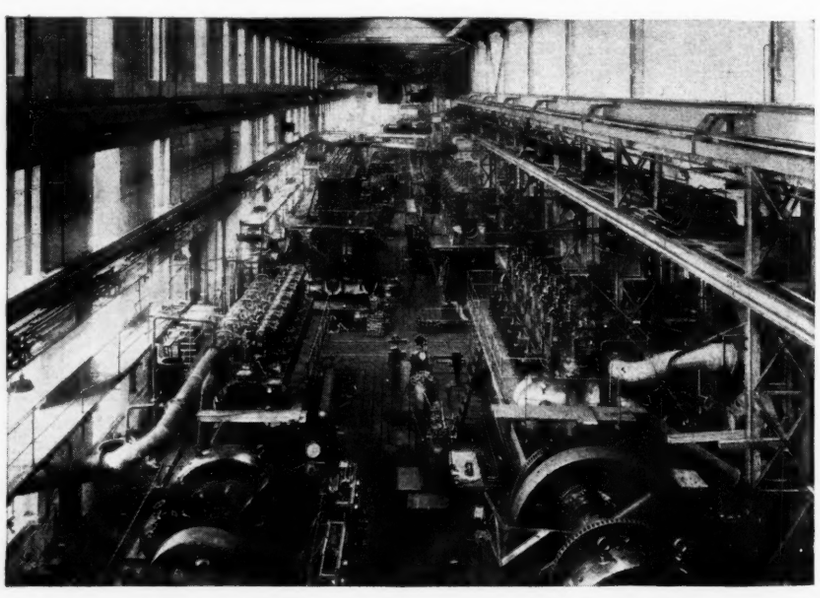
Up to the war period the fuel in all diesel motors, irrespective of size and type, was injected by a high-pressure air blast, although there was another type of oil engine employing a hot bulb into which the fuel was forced directly by a pump at relatively low pressure. The advantages of eliminating the high-pressure, complicated air compressor and avoiding certain other objections to air injection, while at the same time improving upon the hot-bulb type were appreciated a long time ago, but it was not until the war that practical methods were found for injecting fuel directly into the combustion chamber of the diesel while retaining the reliability and other good features of the air-injection type. This was an almost simultaneous development in the United States, England, Germany and elsewhere, and has spread like wildfire throughout the industry, so that, while air-injection engines are still being built and will not be entirely superseded for some years to come, practically all new types, irrespective of size or other characteristics, are using the airless, or solid, injection. Naturally, due to the size of cylinders and the importance of the installations, it was not applied to large central station engines until after there had been considerable experience with it in the smaller sizes. It is now employed in central station units of the largest size including cylinders up to 840 mm. (33⅛ in.) in diameter.

Not only has the size of units increased, but the size of diesel installations has grown much as it has in the case of steam-turbine plants. For instance, the Shanghai, China, power plant now has a capacity of about 30,000 hp., and the order recently placed in this country at Vernon, Cal., calls for 35,000 hp., in one installation.

One Swiss plant is now installing over 22,000 hp. The Maria Elen. Tocopilla, nitrate plant in Chile has over 21,000 hp. installed. There are a large number of central stations in Europe, South America and the Orient of between 5,000 and 20,000 hp. The Panama Canal Zone plant has 12,000 hp. of Nordberg engines and there are several central stations of between 5,000 and 10,000 hp. of American-built diesels.

In the United States the double-acting diesel was first applied to marine service less than ten years ago and is now being applied to central station service in what will be the largest single land installations made at one time in the world. While several American manufacturers have produced diesels of between 3,000 and 5,000 hp., the Vernon plant will have the first American-built engines larger than that. We are building the biggest steam turbines, but we are considerably behind our European friends in building large diesels. While taking the largest European diesels compared with the largest European steam turbines, the ratio of maximum capacity is about 1 to 7, the ratio of the largest American diesels compared to the largest American turbines is only about 1 to 20 at the present time.

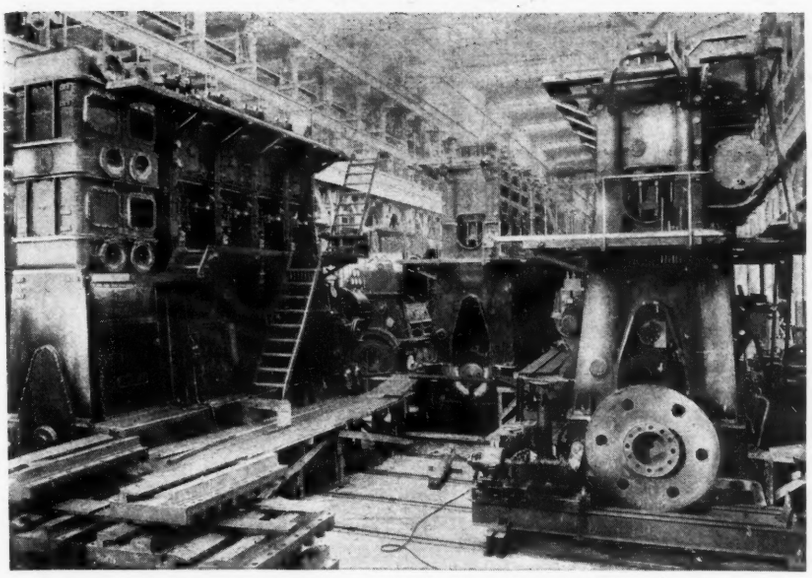
The two-cycle motor followed a few years after the four-cycle, and has until recently had a hard fight with the latter. Now for land service the four-cycle still maintains a strong position up to about 2,000-hp. units and practically dominates the field below 1,000 hp. It is still limited to less than 500 b.hp. per cylinder but the number of cylinders has risen to 8 or 9 in line. The two-cycle becomes formidable at somewhat less than 1,000 hp. and practically dominates the field up to 2,000 hp. The single-acting is practically limited to about 800 hp. per cylinder. It looks as if the double-acting two-cycle already dominates the field, for everything over 4,000 hp. and it may even eliminate the single-acting two-cycle, and begin where the four-cycle leaves off. In the United States the two-cycle, due chiefly to the great activity of the manufacturer, holds a relatively more important position in the 1,000 hp. and less class than it does in Europe.



Test floor of the M.A.N. German diesel manufacturer

Typical of the largest units are the 5,600-hp., 160-r.p.m., 7-cylinder M.A.N. two-cycle double-acting engines with air injection, in Chile, and the 9-cylinder 15,000-hp. 94-r.p.m. engine of the same type at Hamburg. These are of the same general design as the engines to be installed at Vernon, Cal., save that the Hooven-Owen-Rentschler engines for Vernon will employ solid injection.

Sulzer Bros. has completed an 11,000-b.hp. two-cycle double-acting air-injection engine for one central station



Double-acting two-cycle M.A.N. diesels in process of erection

and are building three 7,400-b.hp. 187-r.p.m. 8-cylinder, 600x1,000-mm. solid-injection engines for a Swiss electricity works. Burmeister & Wain, of Denmark, is building a 22,000-b.hp. two-cycle double-acting 8-cylinder, 840x1,500-mm. engine for a Danish electricity works. Carels of Belgium has built a 4,000-hp. two-cycle double-acting Worthington-type engine for a central station in the Argentine. Several other manufacturers such as Krupp, A.E.G. and Werkspoor have carried on similar work on the Continent. In England Docksford and Fullagar with their opposed piston engines have supplied many units which in a way correspond to the double acting.

Technically the oil engine for central-station service is equal to the steam plant in units up to from 5,000 to 7,000 hp. and is now proving itself in units of from 10,000 to 25,000 hp. and larger. Several plants of 15,000 to 30,000 hp. are in successful operation and plants up to 100,000 hp. are now practicable.

The selection of type of power plant, hydraulic; reciprocating steam or turbine, with oil- or coal-fired boilers, high or low pressure, as against oil engines is an economic problem. The growth of the size of the units and the steady increase in total horsepower and number of units in use, supplemented by the authenticated profitable results of operations of many plants, both private and municipal in this country and abroad, proves that the oil engines is a good investment when properly utilized. Local conditions, such as kinds and prices of available fuel, regularity of supply of fuel, load factors, especially peak load demands, seasonal variations in load and probable growth of load are important features to be studied. Others are such as fuel-storage space, the important question of quality and quantity as well as price of water, and the heating load, if any. Generally speaking, questions of personnel for running the plant, the occupancy of adjoining property, as bearing on noise, vibration, smoke, fine ashes and odors, as well as space occupied and the cost of the building have relatively little bearing on the selection of type, because there is, in these respects, little difference between oil engine and steam plants when the specifications are equally good.

The design of power plants of 100,000 hp. and smaller should be predicated on the assumption that steam engines and oil engines are equally available and equally reliable and that the choice between the two must be made for each station on the economics of the case after an adequate comparison of first cost and operating costs including capital charges. If the choice is diesels, then make the installation just as complete and as good as the steam installation would have been had it been selected. There are good steam plants, and cheap, inefficient ones. There are good diesel plants, but unfortunately there have been too many poor ones. Comparisons must be made on the basis of equal quality. An incomplete overrated diesel plant will not have the reliability of a good steam plant, nor will a poor, inefficient steam plant have either the earning power or give the continuity of service of a first-class diesel plant.

We need both steam turbines and diesels in the United States. We need more and larger diesels for home use. In addition our manufacturers should be able to get a much larger share of the South American and other foreign orders. Do they realize that central stations of from 5,000 to 30,000 hp. are being installed on a considerable scale even in these hard times, and that each such station means from $125,000 to $750,000 to the engine manufacturer?

We export sewing machines, typewriters, automobiles and steam turbines. Why not really export oil engines instead of just sending occasional samples?

This is the second of a series of articles the first of which appeared in the Oct. 13 number. Others will appear in subsequent issues; particular attention will be given to European developments.

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Cleaning Large Fuel-Oil Storage Tanks

PRECAUTIONS to observe in the cleaning of large fuel-oil storage tanks is contained in a manual on "Cleaning Petroleum Storage Tanks" prepared by the American Petroleum Institute's Committee on Accident Prevention in Refineries.

Mixtures of petroleum vapors and air are explosive when the vapors are present within certain limits called the lower and upper explosive limits. For average gasoline and crude-oil vapors these limits are generally from 1 to 6 per cent by volume of vapor in air. For lighter products such as commercial butane the upper limits may be as high as 8.5 per cent. For natural gas the limits are about 5 per cent and 15 per cent.

Even after a tank has been once freed of vapor, explosive mixtures may be again formed through the admittance of vapor or gas from some other source through an unblanked line of connection, or by the evolution of vapor from the sludges or sediment within the tank.

How Many Engineers Are Now Unemployed?

Analysis of a survey based on the Engineering Societies Employment Service and various state and government agencies

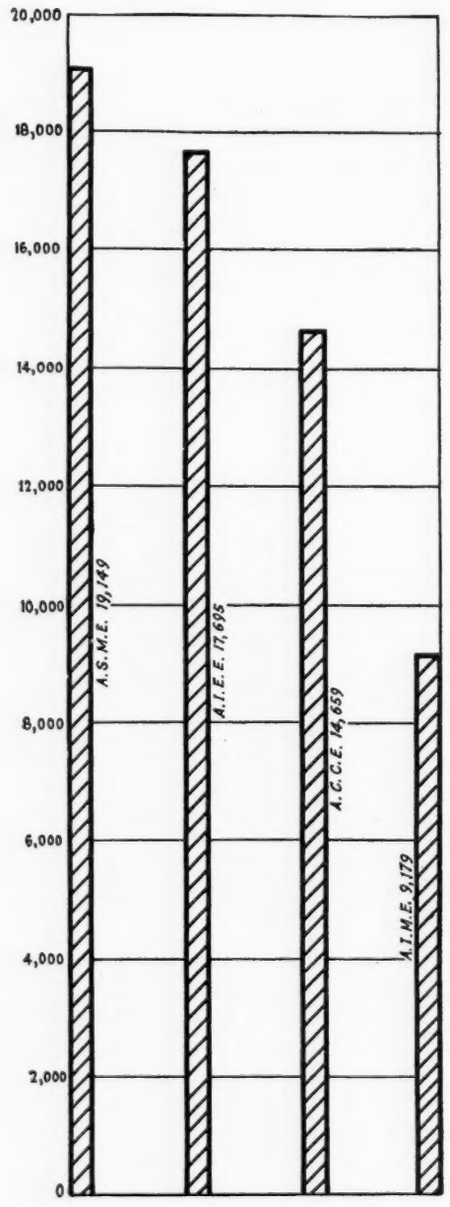


Fig. 1—Total membership of four Founder Engineering Societies as of January, 1931

By H. M. FRIEND*

AS ENGINEERS are much more subject to unemployment than the members of other professions, such as the law, medicine, etc., it would be of great interest and value to have available statistics that would show the number of engineers in the different classifications now unemployed. Such data could be made the basis of programs to help the immediate unemployment and distress among engineers and would also be of great service in long range planning to prevent the recurrence of similar situations in the future.

It is inherent that figures on unemployment can never possess a great degree of accuracy. The totals are constantly changing and there is no practical way of registering every person. In certain foreign countries where there is a dole or unemployment insurance such records are kept and are perhaps fairly accurate. But in this country there is no setup registering all who are unemployed and making the data immediately available. The United States Census of 1930 included unemployment, but these statistics will not be available until the end of this year, and the numbers unemployed have increased greatly since that count was taken.

When this study of the present unemployment among engineers was planned it was thought that the best method of attacking the subject would be to investigate the unemployment situation in the major engineering societies whose headquarters are located in the Engineering Societies Building in New York City, and to obtain statistics from them, if possible, regarding the unemployment among their members.

The four largest of these engineering societies, have maintained jointly for thirteen years an employment department known as the Engineering Societies Employment Service. The statistics of this office were found to be the latest and most practical source of information for a study of unemployment among engineers and were used as the basis for this investigation.

It must be realized, however, that even this source of information cannot give the exact number of engineers unemployed in these four societies as members may register who are employed but who desire to make a change, and unemployed men who register in this or in previous years may have obtained a place without withdrawing their records from the files of the employment service. This study does show, however, the trend in unemployment over successive years and the comparative amounts for the societies represented. Also by making certain assumptions the total unemployment in these societies may be estimated approximately. Certain other interesting deductions can also be made.

To check other possible sources of data bearing on

*Mr. Friend is a graduate electrical engineer of nearly twenty years' experience in appraisal, inspection and power plant construction work and has been connected with several well-known operating companies and consulting engineering firms.

this subject letters were written to a number of other bodies. Among the answers received were the following:

Commonwealth of Massachusetts, Department of Labor and Industries—"We have no statistics which indicate the present situation with reference to engineers. Our surveys are not made on an occupational basis."

Commonwealth of Pennsylvania, Department of Labor and Industry—"This department has no specific information concerning the amount of unemplayment for persons engaged in specific occupations such as the engineering professions named in your letter."

State of New York, Department of Labor—"None of our material directly applies to your problem, since we are not able to compile employment statistics for specific occupations such as engineers."

American Federation of Labor, Washington, D. C.—"I am sorry to inform you that we have no unemployment figures referring to engineers. Our statistics are collected from trades unions in a number of different industries and some stationary and operating engineers are included in the reports, particularly in the building trades unions."

Bureau of the Census, Washington, D. C.—"The tabulation of these returns by occupations which will give separate figures for technical engineers has not yet been completed and figures will not be available before the end of the year."

The President's Emergency Committee for Employment, Washington, D. C.—"I very much doubt whether a figure on total unemployment among engineers is available anywhere. Probably the applications received by the Engineering Societies Employment Service are the only index available, and of course this does not give totals. There can be no doubt, however, the unemployment is more severe among engineers than in nearly any other trade or profession. Probably more than 20 per cent of the graduate civil engineers are out of work and the same condition no doubt, applies to the mechanical, electrical and mining fields.

"Moreover, the salary scale of engineers is being beaten down because so many highly trained men are willing to accept work on almost any terms. These general facts are beyond dispute even if they cannot be backed by actual figures."

From these answers it is evident that there are no sources of statistics in the National and State Governments that throw any light on the unemployment among engineers. Even the census figures which will be soon available cover data obtained more than a year ago before the peak of unemployment was reached.

Therefore this study was based on data obtained from the Engineering Societies Employment Service in New York[1] and this is believed to be the best available source of information and statistics. The author wishes to express appreciation for the courtesy and cooperation of these four engineering societies and of Mr. W. V. Brown, Manager of the New York Office of the Engineering Societies Employment Service for the assistance rendered.

These four major engineering societies are The American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, and The American Institute of Mining and Metallurgical Engineers. In addition to these four societies who have their headquarters in the Engineering Societies Building in New York, the Western Society of Engineers with headquarters in Chicago is affiliated with the Chicago office of the Employment Service. In San Francisco the American Chemical Society of California and the Engineers Club of San Francisco are connected with the San Francisco Office.

As the data in this study are based mainly on registrations, positions received, and placements, each of these will be described. The registrations may be classified into three groups:

1. Men who have lost their positions or expect shortly to be dropped and are actively in search of a new place. It is reasonable to expect that most members of the

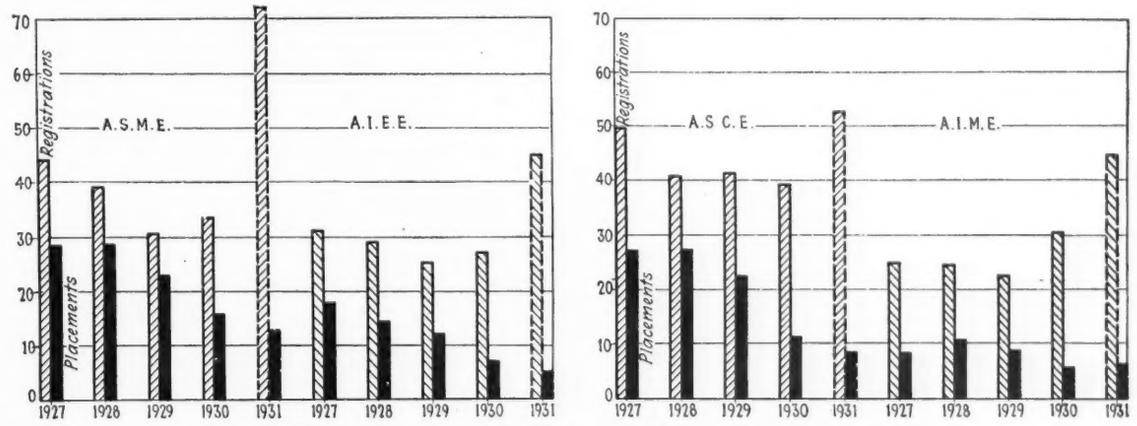


Fig. 2—Registrations and placements per 1,000 members by employment service for each of the four societies 1927 to 1931

[1]This employment department was started in New York in Nov. 1918. It is supervised by a local advisory committee consisting of the Assistant Secretaries of each of the four national societies mentioned and has a manager. Previous to this the A.S.M.E. and the A.I.E.E. had their own employment services. The present service was run on a free basis until September, 1923, when it was changed to a paid basis. The income consists of an appropriation from the four national societies, subscriptions from the "Weekly Bulletin of Positions Open" and voluntary contributions from men placed. No charge of any kind is made to the employer. Normally this office is self-supporting, but during the present depression is being supported mainly by the four societies.

In 1925 the Chicago Office was opened. This office is managed by an advisory committee consisting of a representative from each of the four national societies and The Western Society of Engineers and a Manager.

In Jan. 1926 the San Francisco Office was opened with a local advisory committee consisting of representatives from each of the four national societies, a representative from the American Chemical Society and from the Engineers Club of San Francisco.

affiliated societies who are now in this situation have registered.

2. Men who are dissatisfied with their positions and desire a change. At the present time the percentage of this type is undoubtedly lower than normal.

3. Men of very special qualifications and experience who feel that by being registered they may be put in touch with some company needing their special qualifications.

There are of course some members who have lost their positions and have not registered, but these are probably a small percentage of the total at present. Therefore, it may be assumed that the total number of men registered at any one time will be greater than the total number unemployed but will give an index of the number out of work.

The total number registered is partly cumulative as it will include some who registered in previous years, who

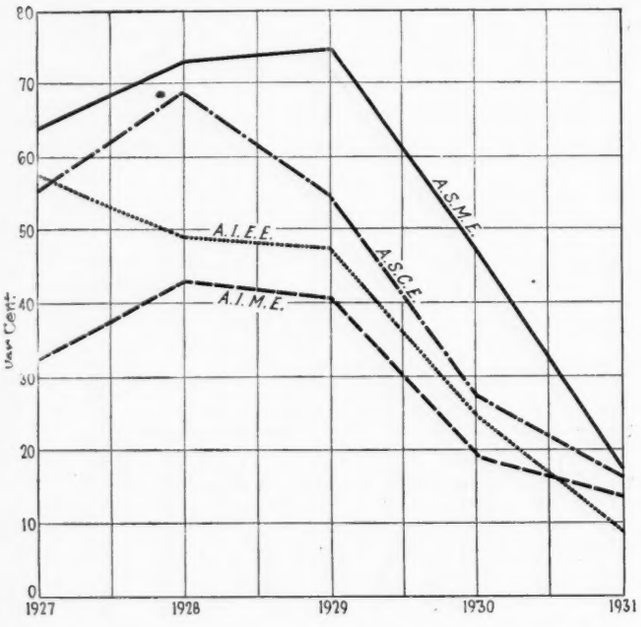


Fig. 3—Percentage of registered men placed (totals for three employment offices) for each of four societies

are now located but have not notified the Service to remove their records from the files.

Positions received come from employers desiring engineers.[2] In many cases the employer uses other sources of obtaining an engineer in addition to this one and may obtain his man in that way. Often he is looking for a man of such special qualifications and experience that he may be unable to obtain him immediately. Some positions remain open for a long time without being filled through the Service.

Generally the requirements for any position require an engineer of specialized experience. Therefore the number of men who can apply for any one position may be very limited. In normal times the positions received may be greater than the number of men registered during that year, a fact which is not true during depressions.

Placements include men put on temporary jobs as well as those on permanent ones. As a man may be on more than one job in a year the placements may represent a smaller number of men than the number would indicate.

[2]Also other positions which the Employment Service has listed as possible opportunities for the men registered. Among these are civil service positions which are advertised by the government, states, cities, etc. Some of these positions which are listed as positions received never develop, as employers sometimes change their plans and decide not to take men.

Analysis of Statistics by Societies

The total and relative membership of the Four National Societies as of January, 1931, is shown in Fig. 1. This was 60,682.

In order to place the statistics on a comparative basis they have been reduced to figures per 1,000 members. The total registrations and placements during each calendar year for each of the societies were divided by the respective membership as of January 1 of that year. This is shown in Fig. 2. As non-members were allowed to use the service till April 1931 these are included in the other years.

Data for registrations, positions received and placements are now available only for the first six months of the current year. To make the curves comparable with preceeding years the assumption was made that the total numbers for the calendar year would be twice those for the first six months.

Fig. 2 shows that during 1927-1930 inclusive the registrations were greatest for the civil engineers, followed by the mechanical engineers, the electrical engineers and the mining engineers in the order named.

However, during the current year the registration of the mechanical engineers has increased rapidly and is the greatest of the four societies. The mining engineers passed the electrical engineers in both 1930 and 1931.

From this it appears that from 1927-1930 inclusive there was a larger percentage of civil engineers out of work or changing jobs, but that during the present year the mechanical engineers were hardest hit with the civil engineers second followed by the electrical and the mining engineers.

Fig. 3 shows the percentage of the men registered who were placed for the years 1927-1931 inclusive. It is

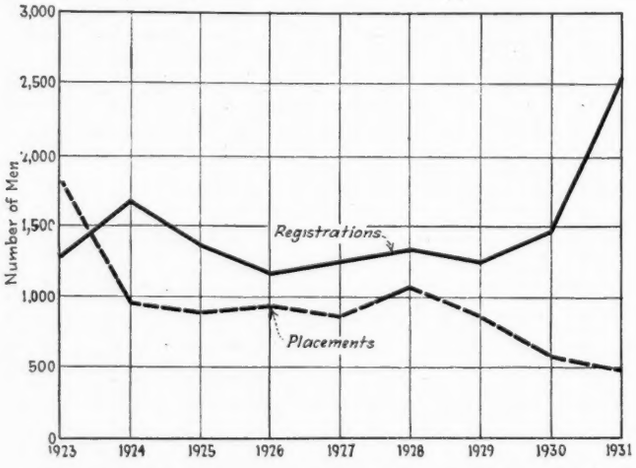


Fig. 4—Registrations and placements of the New York office of the Engineering Societies Employment Services. (Note: Figures for 1931 are summed to be at the same rate as those for the first six months, non-members included until April, 1931)

shown to be highest for the mechanical engineers, followed by the civils, the electricals and the mining. This year the electricals dropped below the mining. In other words there was more demand for mechanical engineers than for the other divisions.

Analysis of Statistics in the New York Office

The change in unemployment from year to year can be judged by the change in new registrations during that year. The number registered and placed for the years

1923 to 1931, inclusive, for the New York office are shown in Fig. 4. In 1923 there were more men placed than registered during the year. As previously mentioned registrations are cumulative. The depression of 1921 was over, business was picking up and men were being replaced. Until 1930 registrations and replacements ran along fairly uniform, but in 1930 and this year registrations increased rapidly while placements fell off very fast.

The percentage of men registered who were placed in the New York office is shown in Fig. 5. It is clearly shown how rapidly this fell off during this year. The percentage of positions open that were filled is also shown in Fig. 5. This runs between 25 and 37 per cent and has not changed during the present depression. In other words on an average only one out of three positions open is filled by the Employment service.

Analysis by Geographical Districts

It is shown (Fig. 6) that during the last three years more calls for men have been received in the New York office than in the Chicago or San Francisco offices.

The curves also show that the registrations increased much faster during the last three years in New York than in the other two offices. San Francisco had a larger registration than the other offices in both 1929 and 1930 but this year has fallen way behind New York. (Fig. 7) This high registration was largely due to the high number of non-members who make use of the service.

Registrations in Chicago have always been the lowest of the three offices. They have increased this year but not as fast as New York. Therefore, it appears that engineers have been thrown out of work more in New York last and this year than in the other districts and that new positions have also dropped off faster in New York. In normal years New York has more positions and placements. The rate of falling off in placing men this year has been practically uniform for the three offices.

To obtain an approximate answer to the question as to how many engineers are now unemployed a study was made of the total number of registrations in the files of the Employment Service. These are classified under three groups:

1. Active records. These include men who are still in search of a position and those who have not notified the Service to remove their records from the files. Probably the great majority of these are now employed. The total number of these active records as of October 1, 1931 was 16,000. It should be understood that these registrations are accumulative and cover several years.

2. Inactive records, which are those who have notified the Service to remove their records from the active files. The number of these up to Oct. 1, 1931 was 10,000.

3. Non-members. These represent men who were previously members of the four societies or others. Up to Oct. 1, 1931 they were approximately 6,000.

From these figures it is evident that the present unemployment among the members of these societies is very high. While it is impossible to estimate the actual number, let us assume a high and a low figure.

If we assume for the high figure that 70 per cent of the active registrations are now unemployed this would give 11,200. To this should be added the number of members of the four societies who are unemployed but have not registered with the Employment Service. Taking this as 1 per cent of the total membership would give a grand total of 11,800 members unemployed.

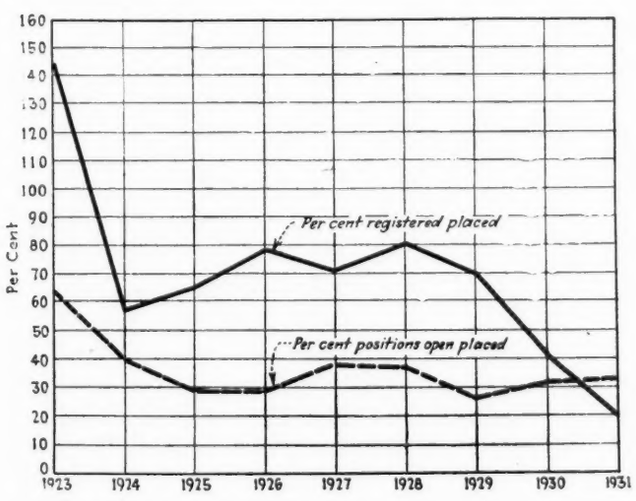


Fig. 5—Ratio of placements to registrations and placements to positions open in New York office of employment service

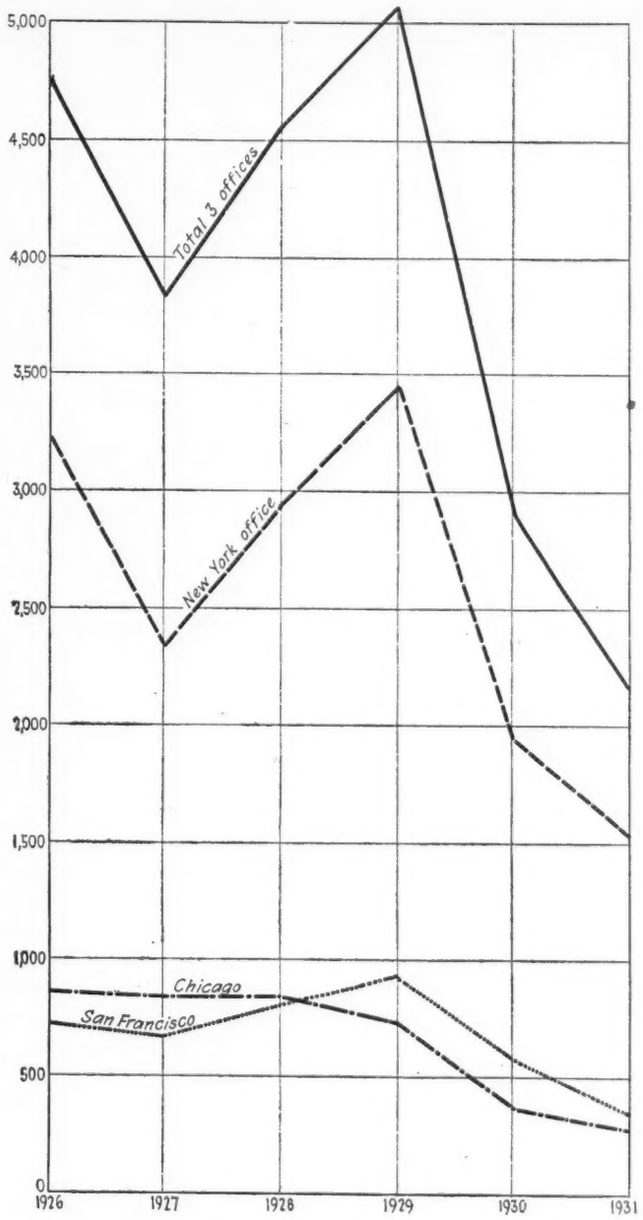


Fig. 6—Positions open (total and in each of three offices) 1926 to 1931; estimate for 1931 based on first six months

For a low figure let us take 50 per cent. This would give 8,000. To this add say 400 for those who did not register and we arrive at a low figure of 8,400. On a percentage basis this gives a high figure of 20 per cent and a low figure of 14 per cent. As a rough figure, we should say the actual number is 10,000 or 17 per cent.

1931 Engineering Graduates

As to unemployment among June, 1931, engineering graduates there are quite definite statistics, which were

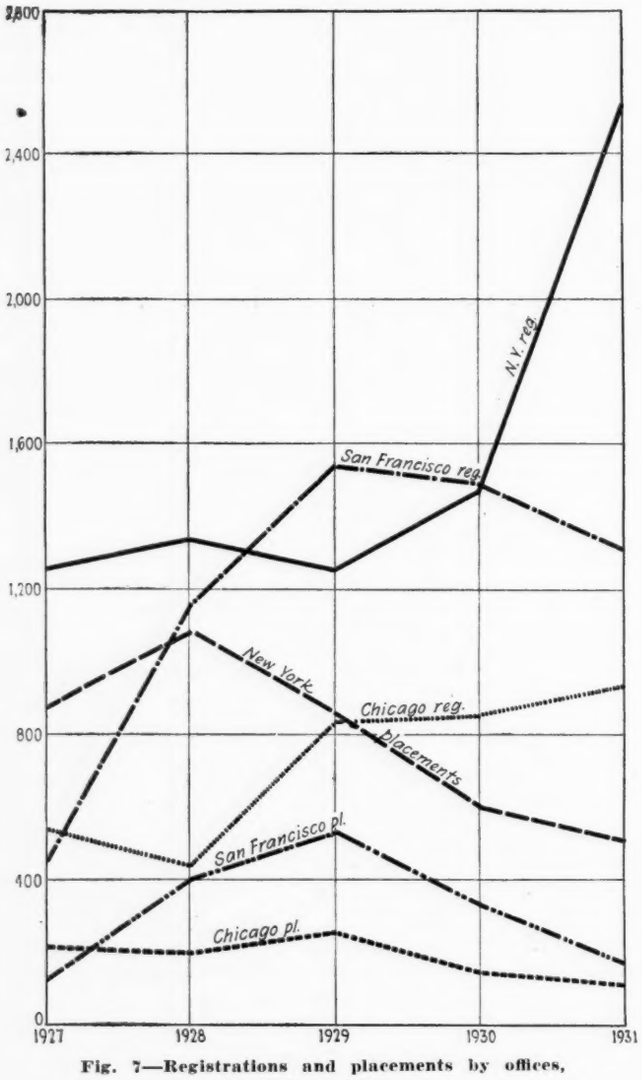


Fig. 7—Registrations and placements by offices, 1927 to 1931

prepared by the Society for the Promotion of Engineering Education. The following summary is based on answers received from a letter under date of May 28, 1931, which was sent to 121 institutions asking for the total number of graduates in the several divisions and the number in each division placed. Replies were received from 88 institutions reporting a total number of 7,184 graduates. Of these, 10 had no information concerning the placement of their graduates. A summary of the 78 institutions is given in the following table:

	Graduates	Graduates Placed	Per Cent Graduates Placed
Electrical	1,609	537	33.4
Civil	1,310	489	37.5
Mechanical	1,202	493	41.0
Chemical	650	301	46.3
Industrial	249	110	44.2
Mining	206	93	45.1
All others	640	217	34.0
Total	**5,866**	**2,240**	**38.2**

The returns showed that the colleges west of the Mississippi had placed about three per cent more of their graduates than those east. In urban centers the institutions placed about 5 per cent less.

From these figures it will be noted that the totals showed that 62 per cent of the graduates were not employed at that date. Applying this percentage to the total yearly number of engineering graduates turned out by the colleges in recent years which was estimated by Col. F. A. Molitor, president, institute of Consulting Engineers, in a radio address on Jan. 9, 1931, as about 10,000, this would indicate that 6,800 graduates of the class of 1931 were unemployed. However, some of these may have since been placed.

It must also be remembered that during a depression many graduates are unable to find a position in the work for which they studied and are taken on by their friends or family in other lines of work. Therefore the actual percentages of placements in the respective branches of engineering in which the student graduated are probably lower than these figures. The actual and relative placements of these different groups are shown in Fig. 8.

Regarding the employment of engineering graduates during recent years Prof. Harry P. Hammond of the Brooklyn Polytechnic Institute stated that in the period 1922-1929, inclusive, there was practically 100 per cent of these graduates placed. In fact at the better known colleges there were four to five jobs open per graduate.

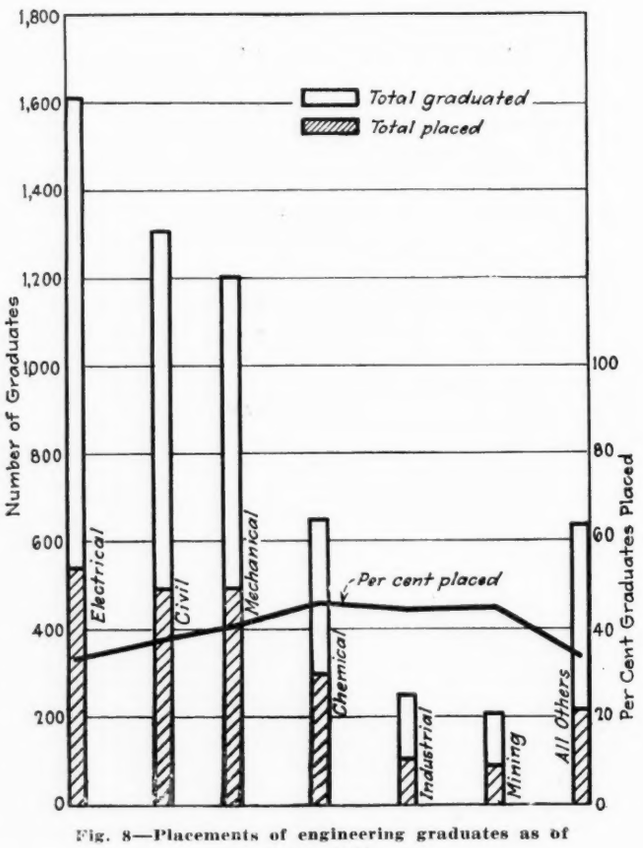


Fig. 8—Placements of engineering graduates as of June, 1931

Some of the largest corporations, like the American Telephone & Telegraph Company, were unable to fill their quotas in certain recent years. Therefore it does not appear that during that period there was an excess production of engineering graduates, as has been sometimes claimed.

To make a true economic comparison of purchased and locally generated power the engineer must know how and where to segregate fixed and variable costs

Accounting Fundamentals Applied to Purchased and Generated Power

By JOHN W. ROMIG
Corning Glass Works

RECENT grouping of utilities has brought about interconnected sources of power available for large and small power consumers. Purchased electric energy has entirely replaced some industrial generating stations, yet many industrial plants are maintaining complete generating equipment and are producing all or part of their own power.

In some plants the absence of records, often due to lack of meters, makes an economic choice between generated and purchased power almost impossible. Both large and small plants should be in a position to procure ample information on quantities and costs so that problems of power economics may he accurately solved.

The power engineer should know power costs in detail from both accounting and operating records. The operating engineer should have sufficient information so that he can make quick calculations concerning the relative economy of various combinations of equipment. Cost records should include all costs, material, labor and fixed charges; while only material and labor are of interest to the operating man.

Boiler Room Costs

The first consideration is the boiler room, for the cost of many power operations is dependent on steam cost. Its determination requires accurate fuel weight and unit cost delivered, amount of water and its unit cost, cost of supplies, repair costs, labor costs that are constant and independent of load, labor costs that fluctuate with load, overhead and carrying charges.

A Meter on Each Boiler

For purposes of computing steam cost the boiler room should include coal handling, feed-water treatment, feed-water heating and all boiler room auxiliaries. If only a feed-water meter is available corrections must be made for blowdown and for steam-driven auxiliaries in the boiler room. A good arrangement from the operating viewpoint is to have meters on each boiler and a coal larry so that evaporation may be checked on each boiler. Such an arrangement enables the operators to quickly detect operating inefficiencies.

In the case of water-softener equipment a meter on the line to the softener permits make-up water to be charged to the boiler room in proper quantities. Heating system and turbine condensate, and the heat in them, should not be charged to boiler room operation. Electric power for auxiliaries should be metered and charged to the boiler room without overhead. High-pressure steam used for auxiliaries should be metered and the quantity deducted from the total steam output to get the net steam delivered.

The steam for the feed-water heater, if exhaust steam from bleeder turbines, should be charged on a basis of per cent of latent heat in the steam as determined by entropy calculations or by a separating calorimeter. If the steam could be used by a mixed-flow or low-pressure turbine it may be charged according to its value for electric power generation. All low-pressure steam charges should be stated in terms of high-pressure steam and subtracted from total steam generated, the difference being the net useful steam delivered to power and operations. The variable and the total costs of steam may then be calculated on a basis of dollars per 1,000 lb delivered from the boiler room. In considering purchased versus locally generated power the computations should be compiled by months for at least twelve successive months so that heat-balance advantages will be given full credit.

Separating Fixed Charges For Economic Comparisons

If there is no immediate demand for additional capacity, then depreciation and other fixed charges do not enter into the comparative steam cost, only material and other variable costs being included. Tabulations

of costs and quantities by months facilitate calculations and comparisons.

Repair and cleaning costs vary with ratings on boilers and number of boilers in service. While the ratio of repair cost to load does not hold constant from zero to 100 per cent load, it may, for practical purposes, be considered as varying directly with the load. Building maintenance is usually fixed and is existent as long as a building is kept in service, regardless of equipment.

The material and other varying costs of steam which form the variable cost are of value in checking the boiler room performance and for comparison with purchased power, where added capacity is not needed. Variable costs should be developed monthly by the power engineer if not available from the cost department records. These figures are really usable for determining economic operating schedules.

Should additional boiler capacity be required the fixed charges covering the additional investment should be added for comparison with purchased power. Extra labor for increased capacity must also be taken into consideration.

Having the monthly steam costs, the next step is to obtain generating costs. If straight condensing equipment only is in place, the problem is simple, providing the steam requirements are metered. If not metered, the less satisfactory manufacturer's water-rate figures may be used. Having the total pounds of steam delivered to straight condensing equipment, the kilowatt-hour output over the period, supplies and auxiliary power, repairs, variable labor, water, etc., the variable cost per kilowatt-hour is readily computed.

If the generating equipment consists of combined mixed-flow, bleeder or straight condensing turbines, the problem has complications. Heating or process steam may pass through the high-pressure stages of the turbines, part going to process or heating and the remainder to the condenser. Here accurate meters provide the only method of checking operation so that power costs may be calculated.

Mixed-Pressure Unit

Consider a station with two condensing units with bleeder and mixed-pressure valves and attachments. Also assume that steam-driven air compressors and auxiliaries supply part of the heat for the heating system and feed-water heater. When the heating system does not take all of the low pressure steam the excess exhaust of the non-condensing air compressors or other prime movers enters the mixed-pressure valves of the turbines, reducing the high-pressure steam demand. Data needed for computations includes steam to each turbine, condensate from each turbine, steam to other prime movers, power output, power to auxiliaries, heating and process-steam demands.

Assuming that no low-pressure steam leaves the system through vents, all steam is accounted for as power, as steam to the feed-water heater, the heating system, and condensate from the condenser. The quantity of high-pressure steam to turbines and prime movers is known, the steam condensed is known, and corrected for gland sealing water, etc. The heating system, process steam and feed-water heating requires from the turbine and prime mover total the difference between the total pounds of high-pressure steam to prime movers and the total condensate. The percentage of the steam chargeable to power generation can be found from a constant-entropy calculation.

Having the quantity of steam that can be charged to electric power, steam cost kilowatt-hour can be computed if the output is known. Repairs, oil, supplies and auxiliary power costs can be added as other variable costs per kilowatt-hour. For total fixed plus variable costs, fixed charges may be provided as a rate per kilowatt-hour.

Computations should be made monthly for twelve consecutive months so that weather conditions and heat-balance advantages tie in together. Electric power cost during winter months, when using bleeder turbines, is low if the heat balance is good. If exhaust steam is available from non-condensing engines during non-heating months, power costs may be diminished by the use of mixed-flow turbines.

Uses of Variable and Fixed Costs

Rates per kilowatt-hour may be developed as follows:

A—*Variable boiler and variable electric generation costs.* The variable rate is of interest in comparing generated with purchased power costs when no additional equipment is needed.

B—*Variable-plus-fixed boiler and variable-plus-fixed generation costs.* The total rate is needed for comparisons when additional boiler and generating capacity is needed.

C—*Variable boiler and variable-plus-fixed generating costs.* This figure is of interest if sufficient boiler capacity is available, but additional generating capacity is required.

If a complete new plant is needed, then the problem must be worked out on a total cost basis from the data available on equipment to be installed, depreciation on investment, labor, repairs, etc. This figure should preferably be compared with similar existing power plants as a check.

Heat balance is one of the most important factors in the economics of power generation. When considerable quantities of steam pass through turbines to heating system or process it is often difficult for power companies to offer power at rates that compete with generation costs involved. Double utilization of steam by bleeder and mixed-pressure turbines is a heat-balance factor materially lowering costs of generation.

Purchase or Generate?

The problem purchased versus generated power may assume different aspects, according to rate offers and local conditions. Variations are shown in the following cases:

Case 1—A power company may desire to offer attractive rates if all power is to be purchased. Under such conditions, the boiler room will be required to furnish steam for miscellaneous prime movers, process, and heat only.

Case 2—The problem may be to relieve an existing power plant of part of its load.

Case 3—Additional capacity may be needed.

Case 4—A check in costs may be desirable in a plant buying power and simultaneously operating turbines and equipment at partial ratings. Under such conditions the true economic situation should be investigated at intervals.

In attacking the individual problem variations exist. Assume that the problem (Case 1) is one of comparing the economics of buying all of the power or of proceeding on the past operating basis. The best way to get at the problem is to compare actual variable costs

month by month for the preceding twelve months with the cost for the same months if power had been purchased and the boiler room operated as a process steam and heating steam plant.

In one total there will be the actual variable costs, while in the other total will be the costs of heating steam, process steam, steam for driving steam-driven machines, and, in addition, the cost of purchased energy computed at the rates indicated in proposed rate schedules. The average variable steam cost for the previous year may be taken as the cost under part loads in almost every case, as variable costs are practically independent of rated boiler capacity.

Total annual cost of actual operation for the twelve months when compared with the calculated total as determined under the purchased power conditions shows the relative value of the two methods of operation. If meters are accurate and calculations are properly made, the results are a safe base to a decision regarding the method of operation to follow for greatest over-all economy.

The problem (Case 2) may be to buy some power and still operate an existing plant. Apparently attractive purchased-power rates for part load may be offered. Steam-driven equipment and turbines would be operated to furnish only the process or heating-steam requirements, and steam from engines or compressors used for mixed-flow turbine operation. Operation of this type usually allows maximum advantages of heat balance and attractive purchased-power schedules.

The problem in Case 2 requires analysis month by month to show the number of kilowatt-hours that may be generated by supplying just enough steam to generator prime movers to satisfy process or heating-steam demands. Average load conditions must be arrived at from a study of operation records. From tests the steam rates of prime movers and costs of operation must be worked out for part leads. The value of low-pressure steam as an energy source may be found by testing. In one particular installation it was found that two pounds of exhaust steam entering a mixed-flow turbine was approximately equivalent to one pound of high pressure steam. Having the amount of process and heating steam required, the load-steam curves for prime movers and the average rating conditions, all over monthly periods, the amount of energy that could be generated is readily found. By subtracting the monthly kilowatt-hours generated from the kilowatt-hours required, the cost of the difference is calculated from the purchasing schedule, making sure that maximum demand clauses are properly applied.

Should a plant (Case 3) need additional equipment requiring certain investments, then the procedure is the same as for Case 2 except that the costs compared should include fixed charges for additional investment. The purchased-power cost should not be credited with fixed charges on existing equipment or the comparison will be misleading.

A plant (Case 4) may be buying power and at the same time operating turbines at part load. Under such conditions an economic balance should be made to show what quantities of power should be purchased and what quantities should be generated. At part loads turbine steam rates increase and there may be distinct advantages in shutting turbines down some months of the year. Again, a balance may show that the purchase of power is more costly than generating all of the power except the minimum on the schedule.

All of the economic studies here presented require a comparison of actual operating costs with costs that would have been in effect had a different operating plan been followed. Costs are compared on a monthly basis and on an annual basis for a complete calendar year. This method may require some adustment in case of a plant making rapid growth or other adjustments due to business conditions, extreme weather conditions, mismanagement or change in manufacturing processes. It is believed that the method of economic comparison offered herein is the safest from the purchaser's viewpoint.

▼

Manual and Automatic Control For Synchronous Motors

By CARL C. NELSON*

EARLY TYPES of synchronous-motor controllers were manually manipulated. The necessity of closing the field circuit at the right time gave synchronous motors the reputation of being difficult to start. However, the advent of automatic controllers overcame this objection. Automatic synchronous motor controllers are advantageous especially where inexperienced electrical men have charge of them. In some cases automatic controllers are necessary, but it is not generally understood just when a manual or automatic control should be chosen. In general there are three classes of controllers, normal, semi-automatic and full-automatic.

Any of these may include reduced-voltage, part-winding or full-voltage starting. The first class provides manual manipulation of both the stator and field circuits. Its use is limited to plants where there are experienced operators. Low first cost is its main advantage, but because of the advantages of the other types manual starting is decreasing.

Semi-automatic starting makes the synchronous motor control comparable with that of the squirrel-cage induction motor, in that the manipulation of the stator circuits is manual, while that of the field is automatic. It is of considerable use in plants where the operators are experienced with squirrel-cage motor control. Its advantages are that synchronizing is accomplished accurately and no time is wasted in waiting for the motor to come up to synchronous speed.

The third class of starting provides full-automatic operation. Starting and synchronizing are entirely automatic and require only an initiating action, such as pressing a push button, operation of a float switch, pressure switch, time clock, thermostat or similar device. The full-automatic starter when used with float or pressure switches, or similar devices for automatic start and stop operation, does not require the attention of an operator. Automatic starters, when provided with frequency-type synchronizing relays, resynchronize the motor automatically if it is pulled out of step when the motor has sufficient pull-in torque, or if an unloader is provided when there is insufficient pull-in torque.

Automatic starters ordinarily are designed to follow closely both motor and line operating conditions. They provide for continuous operation with protection more than do the other types and are well worth the difference in cost, even when they are not actually necessary.

*Control engineer, Electric Machinery Manufacturing Company.

How Hoistway Door Operation Affects Elevator Service

By HOWARD B. COOK

A method for determining the force necessary for opening and closing different types of elevator hoistway doors and what effect increasing the time of operation has on the door mechanism

HOISTWAY door operation time is an important factor in passenger elevator service. In round trip time the difference between two elevators having speeds of 600 and 800 ft. per minute, both making twelve stops per round trip in a twenty-story building is approximately 12 sec. If the doors on the 600 ft. per minute elevator are operated one second faster, per door, than those on the 800 ft. per minute elevator, the slower-speed elevator will have the same-round-trip time as the faster one.

The time required in the operation of an elevator door depends upon the weight of the door, the width of the opening and the forces applied. The laws of motion can be used in this problem with definite results. Friction in a modern door hanger is very small and its influence may be ignored. It will be assumed that the door is accelerated to the mid position with a constant force and retarded from this point to the extreme position with an equal force. The equation $T = \sqrt{\frac{WD}{96.6F}}$, where W is the weight of the door in pounds, D the door movement in inches and F the force in pounds, allows calculating the time T required for operating any sliding door, when the door movement in inches, the door's weight in pounds and the force applied are known. The equation also shows that the force required to operate a door in a given time varies directly as the weight of the door and directly as the width of the opening or the movement of the door. The force required varies inversely as the square of the time of operation. To reduce the time to one-half requires the application of four times the force. A single sliding door having a width of 48 in., a weight of 140 lb. and a force of 48 lb. applied to it, will open in a time $T = \sqrt{\frac{140 \times 48}{96.6 \times 48}} =$ in 1.2 seconds.

Two sets of curves are given to facilitate the application of the equation. Fig. 1 gives the value of $\frac{WD}{96.6}$ for doors of various widths and weights. Fig. 1 also gives the weight per square foot for doors 7 ft. in height. Fig. 2 shows the relation between the force required and the resulting time of operation. The curves are used as follows:

The ordinate in Fig. 1 representing a door 48 in. wide meets the abscissa representing a door weight of 140 lb. at the curve which represents 70 for the value of $\frac{WD}{96.6}$. The value 70 is then taken as an ordinate in Fig. 2 and at this value it is found that this door can be operated in 1.2 sec. with a force of 48 lb. The time of operation corresponding to other forces can also be found.

Biparting, or center-opening, doors consist of two panels moving in opposite directions. A door of this type having a total opening of 48 in. and a total weight of 140 lb. can be operated in 1.2 sec. with a force of 24 lb. or one-half that required to operate an equivalent single sliding door in the same time. A force of 48 lb. would operate the biparting door in 0.85 second. The time and force required to operate a biparting door are found by assuming that the door is equivalent to a single sliding door of equal total weight and half of the movement.

For example, the total opening width is 48 in. and the total weight of the door is 140 lb. This is the equivalent of a single door weighing 140 lb., moving $48 \div 2 = 24$ in. To find the force required to operate the door in a given time, one-half of the door is considered at a time, or, in this case, one-half of the door weight $140 \div 2 = 70$ lb. and moves 24 in. Assume an opening time of 1.2 sec., then, on Fig. 1, the ordinate representing a door movement of 24 in. meets the abscessa 70, the weight of one-half of the door, at the curve which represents about 17.5 for the value of $\frac{WD}{96.6}$. This value, 17.5, is for one half of the door. For the two halves it will be $17.5 \times 2 = 35$. Using 35 for an ordinate value in Fig. 2, it will be found to intersect the 1.2-sec. time line at a point corresponding to a force of 24 pounds.

Two -speed or two-thirds doors must be considered as two single-panel doors. The slow-speed panel operates the same as a single-sliding door, but the high-speed panel moves double the distance that the slow-speed panel moves. A slow-speed panel having a width of 24 in. and

a weight of 70 lb. would require a force of 12 lb. to operate it in 1.2 sec. The high-speed panel would require a force of 24 lb. for complete movement in the same time.

The total force required to operate the two-speed door in 1.2 sec. is 36 lb. The two-speed door requires a 50 per cent greater force than the biparting door for operation in a given time. Time of operation is the period required for opening or closing. The time required for the complete operation of opening and closing is found by doubling the values given.

Fig. 1 may also be used to determine the total weight of hoistway doors 7 ft. high when the weight per square foot is known. Assume a door 7 ft. high, 40 in. wide and weighing 6 lb. per square foot. To find its weight, follow the 6-lb. diagonal line up to where it intersects the 40-in. horizontal, movement-of-door line; vertically above this intersection 140 pounds is read, the weight of the door.

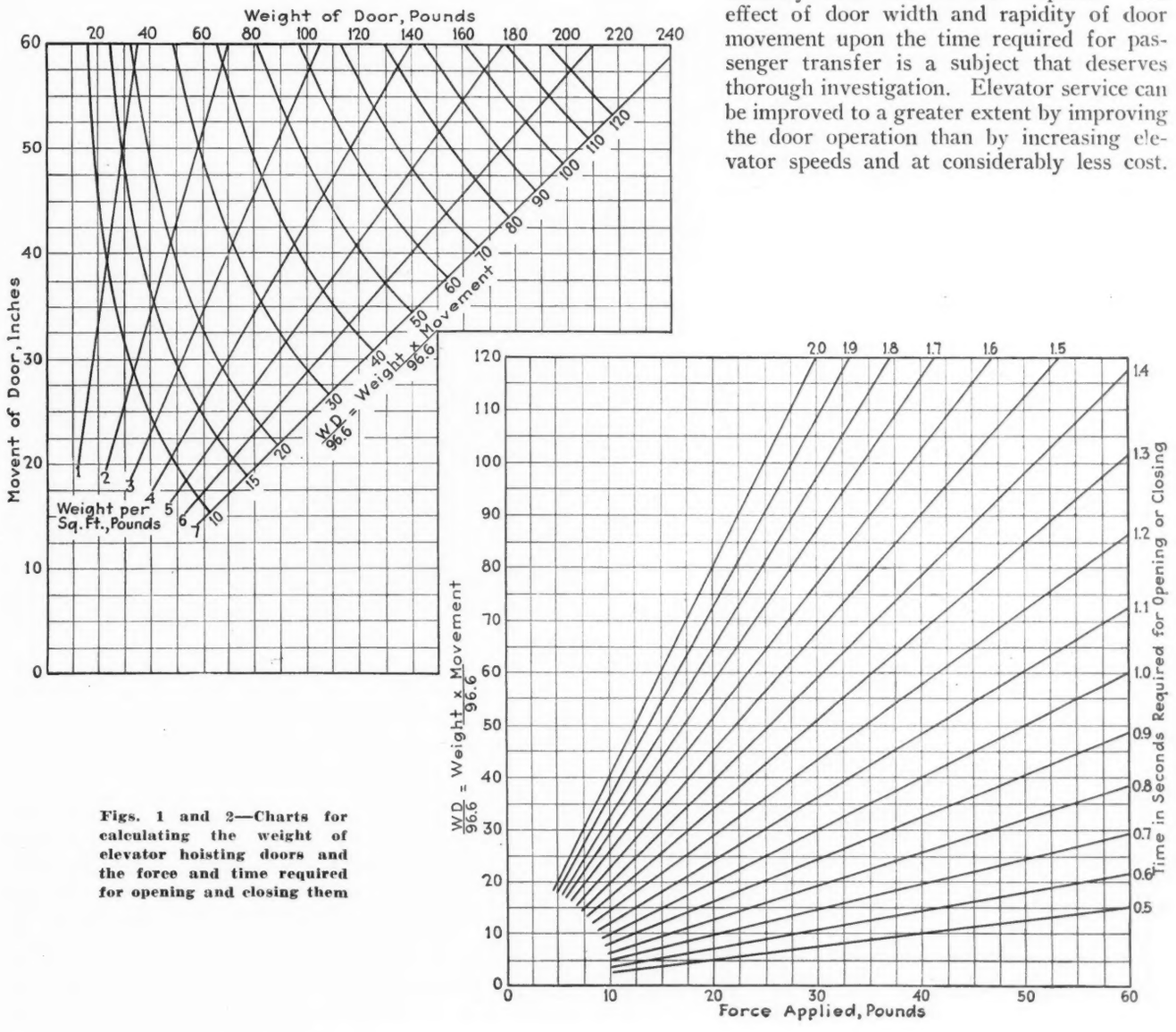
When a manual door-operating device of the spring and dashpot type is used, the operator must apply considerable force to compress the spring in addition to the force required to accelerate the door. The spring absorbs the energy of motion as the door moves to the extreme position. When the door starts to close the energy in the spring accelerates the door until the dashpot brings the door to rest. The energy of motion during the closing movement is dissipated in the air that is forced from the dashpot.

In some of the power-operated devices attempts have been made to conserve the energy of motion in springs or lifted weights, this energy being used to assist in accelerating the door during the next operation.

If a door could be hung like a pendulum from a point, a considerable distance above the center of movement, it would be very easy to catch and hold the door at rest at the extreme positions. Such a door could be operated with very little force.

The danger of being struck by a heavy elevator door is a cause for fear on the part of the passengers. If a door has been accelerated by a constant force of 20 lb. for a distance of 24 in., the energy accumulated will create a force four times as great if an attempt is made to stop the door in a distance of 6 in. To stop this door in 3 in. would require a force of 192 pounds.

If elevator doors are to be operated rapidly they should be made as light as possible, and adequate safeguards must be provided to protect the passengers against injury. It is possible that some arrangement of double doors will eventually be used whereby a very light door is closed quickly and a heavier door is closed leisurely after the elevator departs. The effect of door width and rapidity of door movement upon the time required for passenger transfer is a subject that deserves thorough investigation. Elevator service can be improved to a greater extent by improving the door operation than by increasing elevator speeds and at considerably less cost.


Weight of Door, Pounds
Movent of Door, Inches
Weight per Sq. Ft., Pounds
W·D / 96.6 = Weight x Movement / 96.6
Force Applied, Pounds
Time in Seconds Required for Opening or Closing

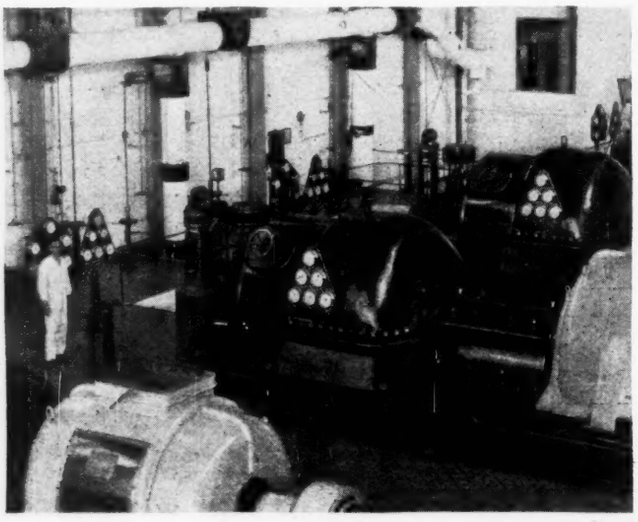
Figs. 1 and 2—Charts for calculating the weight of elevator hoisting doors and the force and time required for opening and closing them

Hongkong Electric Supply System Expanding

By WALTER BUCHLER*

LIGHTING by electricity was first introduced in Hongkong, China, in 1889. At first 75 series arc lamps were used for lighting the principal streets, and these continued in service up to 1912, when gas-filled lamps were substituted.

The consumption of electricity is steadily growing. The Chinese prefer electric lighting and like a lot of it, according to their means. The average Chinese burns from 10 to 25 lights, but when there is a Chinese wedding or any sort of domestic festival the family will apply for temporary additions to its lighting and probably have an extra meter put in. This installation they will keep for one or two days, or even for as long as two or three weeks, the cost of current for such special occasions running from $40 to $50 in the case of a well-to-do family and a few dollars in the case of the poorer Chinese, who limit themselves in the temporary fixtures put in. In some instances, a friend of the family will pay for the electricity and rent of the electric installation as a present to the bride or bridegroom.



Turbine room of Hongkong Electric Company's station

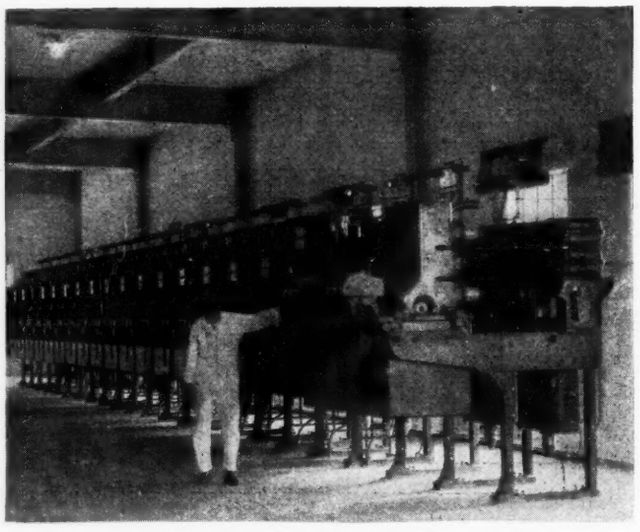
Hongkong is not an industrial port, being mainly concerned with the transshipment of imported goods to various ports of Southern China. Still it has numerous small industries which require electric motors. There are at present approximately 1,500 of these in use, with a total horsepower of 9,000. For the most part these are alternating-current, three-phase. Elevators are in general use, about 160 in all.

Heating by electricity is mainly confined to houses in one section of the city, where it is required for drying rooms to combat the humidity and prevent clothes from getting mouldy over night. In the damp season a servant keeps all blankets and clothes, when not in use, in the electric drying room. As yet, there is little cooking by electricity, because a Chinese cook would soon ruin his employer by his wastefulness if allowed to cook on an electric range.

The better class of Chinese prefer something a little more elaborate in fittings than those usually asked for by a European resident here. They have a tendency to go in for gaudiness, and an electric chandelier with a lustre to it appeals to their taste.

Electrical appliances are bought by only a limited number of Chinese who have the necessary means. They purchase these more for show than anything else, as they continue to use the Chinese "chetty" to do their cooking. A chetty is a simple open stove made of clay or other material, wood being used as fuel. Once a Chinese gentleman who had purchased an electric washing machine in Hongkong asked that an electrician be sent around to his house to look at his machine, which did not appear to be in working order. The electrician found the machine in the sitting room between a pianola and an electric gramophone with beautiful blackwood furniture arranged around. The washing machine had only been used for demonstration to his friends to whom he wanted to show off, while the washing of the house was done by the usual coolie with the aid of a Chinese wooden tub.

Power is generated at the Hongkong Electric Company's plant at North Point, which was erected in 1918 and has a capacity of 27,000 kw. To meet the growing load there are now being added two Stirling-type boilers, each of 75,000 lb. per hour capacity, and a 12,500-kw. Ljungstrom turbine. All boiler feed water is evaporated.



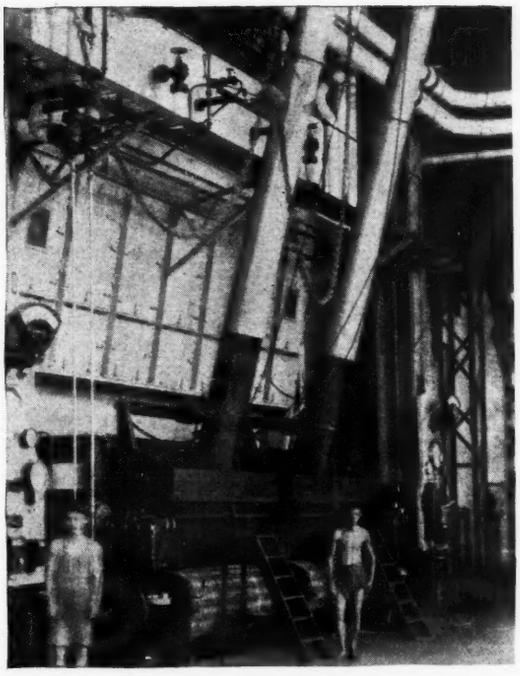
Metal-clad switch gear is used

Coal is received from Northern China and Hongay (Indo-China) by steamer and transferred into junks which are unloaded at the station by coolies with baskets. It is delivered into the storage bunker by a mechanical conveyor.

Current is generated at 6,600 volts, 50 cycles, 3-phase delta. Transmission is largely underground to substations which distribute at 350 volts, 4 wire (200 volts between each phase and neutral).

The Hongkong Electric Company is managed by Messrs. Gibb Livingstone & Company, Ltd., of Hongkong. All the senior posts are held by Europeans and the power station and technical divisions are under the management of British electrical engineers. The locally

*The author, a British engineer, is on an extended tour of the Far East, and has written for *Power* some high-spot impressions of power supply in those countries. His article on "Siam's Largest Power Station" appeared July 28, 1931.



Even where coolie labor is available mechanical stokes are used

engaged staff comprises Indians, Portuguese and Chinese.

Across the harbor, some ten minutes by ferryboat, is the city of Kowloon and the new territories, which were leased to Great Britain by China. There is little room for expansion in Hongkong, hence Kowloon is becoming more and more favored as a residential quarter and as a suitable place for new industrial undertakings, with a consequent increase in the demand for electricity.

There is one power station in Kowloon owned and controlled by the China Light & Power Company, Ltd., a British concern. It has been in existence for close on thirty years, starting with diesel engines but changing to steam turbines in 1918. It serves Kowloon and the new territories, and though not so large as the power station in Hongkong, it is rapidly expanding, its present load being 7,500 kw. This is an increase of 30 per cent in the last year. There are nine boilers and eight turbines of various capacities aggregating 16,500 kw. Two of the machines are 2,500-kw. British Thomson Houston units installed recently. Ninety-five per cent of the new buildings in Kowloon use electricity.

As in the case of the Hongkong station, coal is imported by steamer from Hongay, North China and Japan. It is discharged by coolie labor into junks and then unloaded into bins located alongside the power station.

▼ ▼ ▼

How Frequently Should Inspections Be Made?

By MARIN PHILLIPS

THE TIME between inspections of power equipment will vary widely, depending upon the type, application, conditions under which it operates, judgment of those responsible for the plant and other factors. A schedule of inspections as worked out and applied in one large plant covers weekly, monthly, quarterly, semi-annual and annual periods.

Weekly

Inspect drives having idler pulleys to see that proper clearance is maintained between top and bottom of belts.

Check machine tachometers.

Test sprinkler alarm bells to see that they are in good working order. In winter note if dry-valve houses are properly heated.

Keep track of new equipment and work needed next year, as an aid in budgeting the yearly costs in advance.

Monthly

Inspect, grease and oil, and make any needed repairs on motor-driven hand tools.

Test telephone batteries.

Clean all switches in lighting cabinets and lubricate with vaseline.

Test all compensators for tripping on power failure or overload by raising relay by hand.

Clean, inspect and lubricate the contacts with vaseline on all rheostats. Also lubricate the shafts and see that they turn freely.

Inspect and replace worn brushes on all direct-current machines and slip-ring motors. Also note if the brushes have proper spring tension and work freely in holders.

Clean the slip rings and brushes on all magnetic clutches. Replace worn brushes. Test alignment and adjustment of clutches.

Inspect all automatic signals.

Test oil in power transformers. When the oil shows a breakdown test of 20,000 volts or less, the oil must be filtered immediately.

Check maintenance supplies, such as contacts, bearings, fuses, undervoltage coils, etc.

Quarterly

Shut off power in the power house. Clean all insulators and disconnect switches. Inspect and oil all working parts of main oil switch. Watch for loose or hot connections. Wipe off all dirt, dust and oil around the oil pots. Check the oil level. Examine switch-operating motor bearings, brushes, clutch and operating contacts. Check breaker to see that it trips freely.

On the main switchboard inspect all distribution-line switches. Clean all contacts and outside of tank. Change oil when sludging and sediment are present. Examine terminal connections for heating. See that contacts line up properly. Check breaker to see that it trips freely.

Semi-Annual

Test oil in potential transformers.

Make an insulation resistance test on all main feeders.

Test and inspect control wiring.

Inspect all wiring splices, either open or inclosed.

Inspect, clean and oil all out-of-the-way safety switches that are infrequently opened.

Inspect ground wires on all electrical equipment.

Annual

Paint all electrical equipment. One-third of the total number of motors are to be taken apart, thoroughly cleaned and painted inside. This will insure making the rounds every three years. Make load test on all motors.

READERS' COMMENTS

Improving Maintenance Methods

THE ARTICLE, "Motor Installation Rules Simplify Maintenance," by Marin Phillips, Sept. 22 number, is a definite plan for motor and electrical equipment installation for most any plant. The rules developed as a result of Mr. Phillips' experience will help others to solve operating problems that might otherwise be troublesome. My experience is that maintenance work generally requires study and effort not to allow any part of the plant or equipment to be neglected.

Certain equipment in most every installation gives little trouble and is likely not to be accorded the attention that it deserves. There are other machines that may be difficult to get at and for this reason are liable to neglect to the detriment of the machines. Instructions as suggested by Mr. Phillips will have a healthy effect in eliminating the tendency to neglect certain machines in the plant. They leave no opportunity for workmen to avoid the responsibility of their sloppy work when it is discovered by those in charge.

As an additional help to the maintenance department blueprints should be accessible to all qualified employees who are responsible for the repair and upkeep of equipment. Each man should be required to familiarize himself with the piping and electrical layouts so as to act quickly in an emergency. Accidents occur to water and steam lines that may damage electrical equipment if valves are not closed quickly. When a new man is put on the job, he should be shown over the entire plant, so that he may get a general idea of the layout, after which the blueprints will be more readily comprehended.

If care is taken to provide the workmen with properly written instructions and other information essential to a comprehensive understanding of what is expected of them, guessing does not have to be substituted for certainty when an emergency arises. They will be able to act quickly and correctly. I would be interested in reading how others have improved their maintenance methods.

Brooklyn, N. Y. WILLIAM ANDERSON.

Why So Much Excess Air for Oil Engines?

IT HAS long been proved that the oil engine as now operated needs a much greater quantity of air for combustion than is necessary according to the calculations of chemists. Some results are larger cylinders, greater weight, greater space requirements, greater first cost, an excuse in some quarters for supercharging, and larger surfaces for heat dissipation, this latter a condition that offsets the benefit which might otherwise accrue from the combustion of weak mixtures.

In the face of all this few engineers seem ever to attempt to give a careful, specific explanation of the cause or causes of the need of more air for the combustion of oils than for, say, gasoline. Might not frank attempts at specific explanation of this limitation open up more light on some of our oil-engine problems?

Most of the statements on this combustion limitation of oils when burned in engines are simply assertions that the fact is so. Consideration of this situation seems timely, since the American Society of Mechanical Engineers is beginning to show real interest in the study of fuels for oil engines in the higher speed ranges. Perhaps we could well afford to slump a little on determinations of the degree of atomization and the extent of spray penetration with different nozzle designs and on pictures of further combinations of mechanical equipment, and settle down for a time to a penetrating attack on the determination of just what specific condition or conditions will assure complete combustion of oils, with a close approach to the amount of air theoretically necessary.

There is too much trying to get well-needed results blindly from oil engines. Can oil be burned with a minimum of air approaching the theoretical amount calculated by the chemist? If so, how?

Can that condition be duplicated in a compression-ignited engine? If not, what changes in the fuel characteristics will permit combustion of oil with an approximation to the theoretical air supply? If the limitation now affecting oil-engine combustion lies in the field of chemistry, then surely there must be a job for the chemist to alter our fuels for us; for it can hardly be laid down as logical for the mechanical engineer to undertake the work of the chemist. If, on the other hand, the limitation is due to purely physical causes, then perhaps mechanical engineers can overcome the limitation. But it is essential that more specific information concerning that limitation should be placed in the hands of mechanical engineers.

Some British researchers have joined their voices to those of German investigators in asserting that vaporization seems to play little part in ignition and combustion in compression-ignited engines. But it is highly probable that we are as yet unacquainted with all the paths by which carbon can arrive at its carbon dioxide destination. The worst of our predicament is, however, that so few engineers and scientists seem to have any courageous idea as to what is the most desirable path for this transformation when it is to occur within an oil-engine cylinder. The engineering attitude of mind appears too often to be that of grasping for a result rather than analyzing the means.

Does the chief of a steam power plant specify burning run-of-mine coal as delivered? Is the electric power industry so "tight" that it refuses to prescribe the use of coal crushers? Is it not possible that the reason the coal user is allowed a crusher while the oil-engine man is supposed to burn his fuel without the equivalent of such is because the former can actually watch combustion as it proceeds instead of having to rely upon the assertion by some remote researcher. The oil-engine man is allowed a centrifuge to clean the oil fuel probably because something is to be done that can be seen. How about a little more seeing what it is that makes oil require so much excess air as compared with, say, gasoline?

Initially such seeing is a physicist's or a chemist's job. The mechanical engineer has been using oil in his engines for over a human generation without apparently appreciating the real depth and measure of this problem. Meanwhile, to be able to dodge the vaporization issue by accepting the assertion that vaporization is unnecessary appears to please some mechanical engineers greatly.

If a liquid that may be as much as 99 per cent combustible and contain 15 per cent hydrogen can "stay put," so to speak, for an appreciable time, as time goes in chemical reactions, when splattered in a finely divided

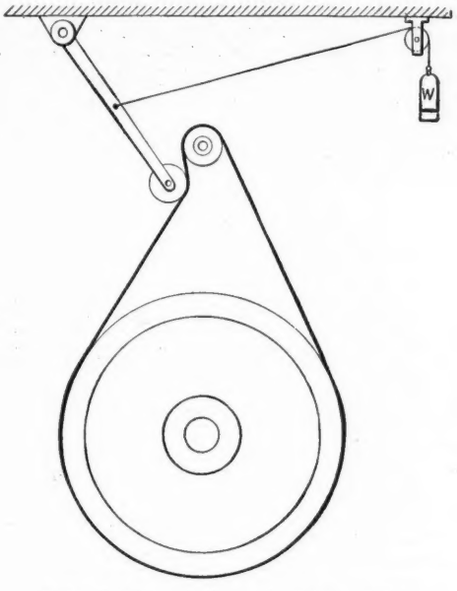
state into the midst of a mass of red-hot air, the reaction must either be slow for a chemical process or else there is some physical condition that must occur first. This suggests that for certain liquid fuels possibly an oil "crusher" is desirable. Nature has provided an oil crusher that operates simply by the direct action of heat. But the physicist does not call its action crushing. He calls it vaporizing. ROBERTSON MATTHEWS.

Bolton, Ontario.

Adjusting Idler Pulley to Prevent Belt Slippage

IN THE PROBLEM on the location of an idler on a belt by D. J. in Sept. 1st number, the trouble may not be due to the idler or its location. The pulley contact surface of the belt may be stiff and hard instead of flexible and soft. A proper use of a good belt dressing will remedy this difficulty.

The trouble may be due to bouncing or vibration in the belt. Sometimes the movement of a belt causes an idler

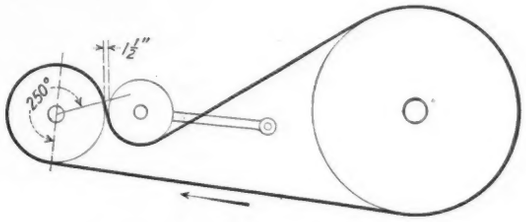


Idler held on belt by tension weight

tot lift momentarily, Every time this movement takes place the tension on the belt is reduced and tends to allow slipping. In one case belt slippage was reduced by installing an idler as indicated in the diagram. By adding to or reducing the amount of weight *W*, a point was reached where the idler ran steady with just the right amount of tension on the belt to prevent slipping.

Toronto, Can. JAMES E. NOBLE.

THE PRESENT LOCATION of the idler pulley allows the belt to slip due to insufficient arc of belt contact on the motor pulley. The idler pulley should be placed close to the small pulley, regardless of whether this or the large one is the driver. With the idler pulley in its proper location as in the diagram D. J. should not have any trouble with belt slippage. It may be necessary to move the motor closer to the compressor to give the belt sufficient slack to allow the idler pulley to come down and increase the arc of belt contact on the motor pulley. This can be easily done where the motor is on sliding rails; otherwise it will be necessary to lengthen the belt by splicing in a piece. Should the idler pulley have a tendency to lift when operating, examine the belt for a dirty or greasy surface before increasing its weight. Most idler pulleys are heavy enough and do not require additional weights or springs, other than what the manufacturers provided.



Idler located close to the driving pulley

Where the belt is dirty or greasy, it should be soaked in gasoline over night. This will dissolve the grease and loosen the dirt, which should be scraped off with a wood block, rather than by using a sharp tool. When the gasoline has evaporated the belt should be given a good treatment on both sides with neatsfoot oil, applied liberally with a swab made of a piece of rag.

Milwaukee, Wis. J. F. WISINSKI.

Pulverized Coal Igniter

IT IS EVIDENT from the answers given in the August 11 number and from P. Richardson's comment in the Sept. 15 number upon the proper location for ignition torch in pulverized-coal burners, that there is a general opinion that ignition torches should be used to carry light loads and for maintaining line pressure, and to bring the boiler back to line pressure from a cold or banked condition.

We have a 19,500-sq.ft. boiler with a two-unit mill installation, each mill having a capacity of 15,000 lb. per hour. There are two horizontal turbulent-type burners to each mill, four burners in all. Our normal steam pressure is 325 lb. at the boiler, and 315 lb. at the turbine throttle.

We have a 30,000-kw. turbine-generator which we run approximately 16 hr. each day. In the shut-down period the steam pressure on the boiler drops to about 100 lb. According to the previous discussers it would be good practice to bring this boiler up to line pressure with the ignition torches. We find, however, that this is not practical. We can bring the boiler up to line pressure using an average of two tons of coal. It takes about 45 min. to do this. The rolling period for the turbine is 1 hr. and 45 minutes.

We find that we can bring the boiler up to the pressure, roll and bring the turbine up to speed, consuming in all about 2 hr. and 30 min. and use an average of 4.5 tons of coal for the operation. To do the same thing with the ignition torches we would have to use around 200 gal. of fuel oil. The cheaper way is obvious.

There is no doubt that a burner type of ignition torch would prove of considerable value, with its ability, but its own power, to keep up steam under light loads when the pulverized fuel fire refuses to function, if there is only one mill to a boiler. It would be of no use in a two-unit mill installation because if one mill is out of order it is entirely possible to carry light loads, or to keep the boiler in a banked condition with the other mill.

Venice, Ill. JOHN G. BRIDER.

Some General Chemical and Physical Properties of Refractories

IN A PAPER before the American Society of Mechanical Engineers, at Kansas City, Mo., on Sept. 7 to 12, 1931, J. H. Kruson presented considerable data concerning the physical and chemical properties of various refractories, as well as some discussion concerning the destructive actions to which the refractories, principally fireclay, are subjected in the boiler furnace.

A number of different refractory materials are available, the most abundant being fire clay, silica and diaspore. In addition, a number of highly refractory ores, such as Chrome, Magnesite, Zirconia, Bauxite, Cyanite and Andalusite are also available, although seldom used as refractory lining for boiler furnaces. In this class would also be included Silicon-Carbide, Fused Alumina and Spinel, which are electric furnace products.

Fireclay, due to its abundance and relative cheapness, is the most commonly used of the refractories. Fireclays are generally classified in four general groups, and are known as plastic, semi-plastic, semi-flint and flint clays. Table I shows typical analyses and fusion points of the four different groups of Missouri clay.

TABLE I—ANALYSES MISSOURI FIRECLAYS

	Flint	Semi-Flint	Semi-Plastic	Plastic
Silica	50.86	52.27	53.42	59.44
Alumina	43.56	40.27	39.81	32.18
Iron oxide	1.78	1.25	1.92	2.20
Titania	1.89	2.17	1.69	1.97
Lime	0.65	0.81	1.03	0.96
Magnesia	0.28	0.36	0.43	0.41
Alkalies	1.12	1.69	1.76	1.85
Deg. F.	3164	3128	3120	3047

The plastic clays have a marked tendency to flake or break down, although they develop a strong bond when tempered or mixed with water. When formed into brick and burned, the resulting product is hard, dense and mechanically strong, but the fusion point is inferior to the semi-plastic, the semi-flint and flint clays. Chemically, the plastic clay carries a higher percentage of impurities and silica.

The true flint clays are much harder than the plastic clays. On mixing with water they are practically devoid of plasticity or bonding properties. Chemically, the Missouri flints approach most nearly to the theoretical composition of pure kaolin ($Al_2O_3.2SiO_2.2H_2O$). Naturally, its fusion range is considerably higher than the other types. The semi-plastic and semi-flint clays are intermediate between the limits as set by the other two. Their fusion points, however, approach more nearly that of the flint than of the plastic clay.

Refractory bricks are used in boiler settings for the purpose of controlling and confining the heat generated to specific areas. Practically any boiler of consequence is capable of generating sufficient heat to rapidly disintegrate the refractory lining, unless means are supplied to protect the refractory from the direct action of the heat. This is sometimes done with water wall installations, of the heat conducted through the brick furnace lining is dissipated by air cooling.

Furnace Temperatures

On forced draft traveling grate stokers, burning Midwest coal, the fuel bed temperatures may range from 2,800 to 3,000 deg. F. Wall temperatures under these conditions seldom exceed 2,650 to 2,750 deg. F. Forced-draft underfeed stokers, under similar conditions, may develop fuel bed temperatures ranging from 2,750 to 2,900 deg. F., with wall temperatures ranging from 2,200 to 2,450 deg. F. Flame temperatures of powdered coal and mechanically atomized oil easily reach 2,800 and 2,900 deg. F. If the flame impinges on the wall it may be practically the same temperature as the flame at that point, although in most installations arches and walls are around 200 deg. F., below flame temperature. Due to direct radiation from the fuel bed or flame, wall temperatures may be as much as 100 deg. hotter than the gases which are flowing directly by them.

While flame and fuel bed temperatures of 2,800 to 3,000 deg. are reached in boiler furnaces, the actual refractory temperatures rarely go over 2,700 to 2,800 deg. Since the average fusion temperature of high-grade fireclay refractory ranges around 3,100 deg., and over, the actual failures, due to the melting of the refractories from heat only, are infrequent. Furnace walls are subjected, however, to destructive actions other than fusion. Among the most common are the fluxing and the erosive and corrosive action due to slag and furnace gases, clinker formation, spalling, failure or deformation under load at operating temperatures, and thermal expansion, although this factor is usually associated with spalling. The rapidity of action of these destructive forces is influenced to a considerable extent by the chemical activity of the refractory at furnace temperatures, its porosity, its density and its thermal conductivity.

Fluxing Causes Erosion

The fluxing and erosive action of slag on furnace refractories is a complex process involving a number of factors. While based primarily on chemical activity and the formation of new chemical compounds between the mineral of the refractory and the minerals of the slag, other factors, such as the temperatures of the furnace walls, the slag and the gases, and the variations in physical and chemical properties of the ash, the fire brick and the gases are of prime importance. Thus nothing more than general predictions may be advanced regarding the exact chemical compounds between slag and fire brick that will result.

The furnace lining has a tendency to become soft and sticky at operating temperatures, and the ash adheres to this surface. Laboratory and field work has established that to withstand the erosive action of low-fusion slag, the fire brick must be highly refractory, fine-grained and of a dense structure, well burned and free from such defects as lamination and cracks. Inferior refractories fail rapidly, due to the fusing of clay grains with the molten slag.

Even though its material may be highly refractory, a brick that has a coarse texture, or has laminations, checks or surface cracks, may fail rapidly, due to the molten slag creeping into every fissure and weakening its resistance to the pasty slag. Frequently, clay grains are discovered apparently unharmed in the slag, due to the eating away of inferior bond clay, thus leaving the clay grain free to wash away.

Table 2 gives typical analyses of four different slags, together with their fusing temperatures. It will be noted that while the principal ingredients of these slags are silica and alumina, there are also appreciable quantities of iron and lime present. These latter, acting as fluxes for the fusing of the silica and alumina, are the cause of the relatively low fusing temperatures of the slag.

TABLE II—ANALYSES OF COAL ASHES AND SLAGS

	(1)	(2)	(3)	(4)
Silica	43.10	33.74	44.52	54.10
Alumina	20.02	26.65	18.64	25.50
Iron oxide	24.00	3.68	31.25	9.70
Titania	.....	0.65	0.76	.....
Lime	6.17	22.59	1.33	3.60
Magnesia	0.09	1.04	1.10	0.80
Alkalies	6.60	6.03	0.63	2.20
Fusing temp. (deg. F.)	1960	1095	1960	2580

(1) Typical coal ash slag from low grade Illinois slack coal.
(2) Slag from walls of a boiler, fired with flax straw refuse.
(3) Low grade Eastern bituminous coal.
(4) Illinois coal ash slag.

The four principal chemical ingredients involved in slag erosion are lime (CaO) and iron (Fe_2O_3) found in the slag, and silica (SiO_2) and alumina (Al_2O_3) found both in the slag and in the fire clay or refractory. The lime and iron both act as fluxes. While pure lime (CaO) has a high fusing temperature running over 4,600 deg. F., iron oxide (Fe_2O_3) has a very low fusion point, and chemical mixtures of the two develop compositions having a very low fusing point and acting as fluxes. This is shown in Fig. 1, which is an equlibrium diagram for the system CaO—Fe_2O_3. As the percentage of lime decreases with consequent increase in the percentage of iron, the fusing temperature of the mixture drops rapidly until at about 8 per cent CaO and 92 per cent FE_2O_3 the fusion point is dropped to about 2,200 deg. F.

Thus while the temperatures developed within the furnace are well below the fusing temperatures of the refractories themselves, and also of the individual ingredients of the slag, the fluxing action of the iron and lime in the slag, and the low-melting-point com-

positons formed by them with the silica and alumina, results in the melting and washing away of the fire brick, even at operating temperatures. The action is not due solely to the effect of heat on the refractories, but is rather the result of the fusion of the chemical compositions formed.

The melting takes place progressively, the material of lowest softening temperature melting, and gradually dissolving the more refractory structure. A complex mixture of slag and brick results, and as the operation proceeds new lower-fusing compounds may be formed, finally resulting in aluminum silicate and silica glass, accompanied by compounds of iron, lime and the alkalies. Mullite and Magnetite (Fe_3O_4) are probably also present in these resulting compounds.

During the process the four chemical ingredients combine with one another into various systems, the lime with the iron as shown in Fig. 1, and also with the silica and the alumina. In turn both the silica and the alumina can combine with the iron and with each other to form similar systems having lower fusion points than the ingredients by themselves. These combinations can again recombine with each other to form still lower melting compounds, which are, consequently, the cause of severe dissolving action on the refractory.

The action of the iron-bearing slag depends to a considerable extent on whether an oxidizing or a reducing atmosphere prevails in the furnace. Ferrous oxide combines with silica to form ferrous-silicate, which fuses at a comparatively low temperature. On the other hand, ferric-oxide combines with silica to form ferric-silicate, which, fortunately, has a relatively higher fusion range than the ferrous-silicate. In any case, the make-up of the furnace gases which transport and deposit the ash on the furnace walls is a highly important factor in slagging action.

The more viscous slags accumulate on the wall. When they build out sufficiently to interfere with operation they are cut off or knocked off, and in so doing the bricks are frequently loosened in the wall, or broken. This action is very detrimental to the refractory, not only because of the carrying away of portions of the fire brick with the slag, but by the exposing of the inner granular structure of the brick to further slag action as soon as the boiler is put in service again.

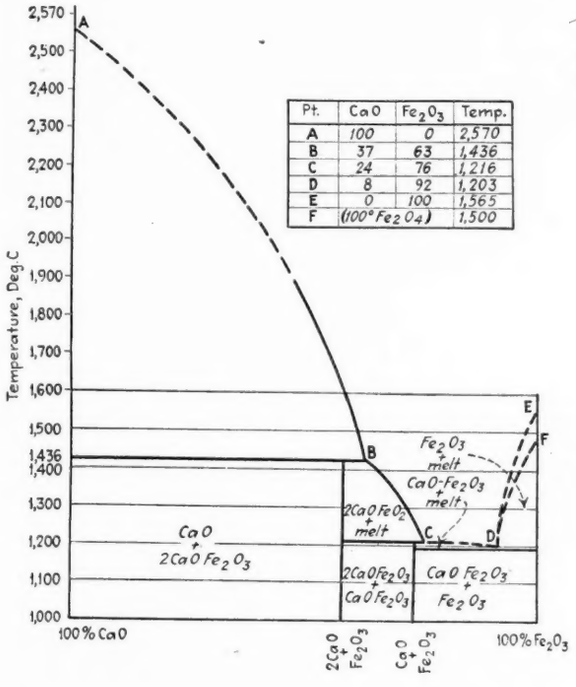
Slag action is at a minimum with oil and the gaseous fuels, due to their relatively small mineral content. Other actions destructive to the refractories, such as spalling, flame impingement, and deformation under load, due to the high temperatures, occur however even with these fuels.

Spalling is generally the result of frequent heating and cooling of the refractory where drastic temperature fluctuations occur. It is aggravated by high temperatures and external stresses, as well as by failure to make adequate allowance for expansion. Under the action of heating, fire brick increases in size, and consequently shrinks on cooling. The thermal conductivity of fire brick is low, and thus during the period of heating, the surface exposed to the furnace gases heats up much more rapidly than the inner section and the outer face.

Once the brick has reached an equilibrium of temperature this inner exposed surface would drop more rapidly in temperature during a cooling action. Since the inside of the brick responds more slowly to temperature change than the exposed surface, internal stresses result, which frequently cause portions of the brick to break away. If the temperatures are sufficient to cause vitrification of the exposed surface to a depth of an inch or two, the spalling tendency is accelerated. Oil- and gas-fired furnaces tend to exaggerate the spalling action, due to sudden bursts of flame, causing wide local fluctuations in refractory temperatures. The curves of Fig. 2 show the average thermal expansion for four different types of fire clay brick.

TABLE III—ANALYSES FIRE-CLAY CEMENTS

Ignition loss	4.42	5.52	2.47	4.00
Silica	49.78	74.65	56.39	72.77
Alumina	35.81	13.07	35.62	14.81
Iron oxide	2.87	1.42	0.75	3.92
Titania	2.32	1.41	1.64	1.14
Lime	0.33	0.34	0.21	0.20
Magnesia	0.63	0.09	0.18	0.10
Fixed alkalies	1.69	1.57	2.45	0.87
Sodium silicate	2.63	2.97	2.81	2.55
Total	100.26	100.36	102.52	100.36
Fusion temp., deg. F	3038	3786	3080	2674



Pt.	CaO	Fe_2O_3	Temp.
A	100	0	2,570
B	37	63	1,436
C	24	76	1,216
D	8	92	1,203
E	0	100	1,565
F	(100% Fe_2O_4)		1,500

Fig. 1—Equilibrium Diagram CaO-Fe_2O_3

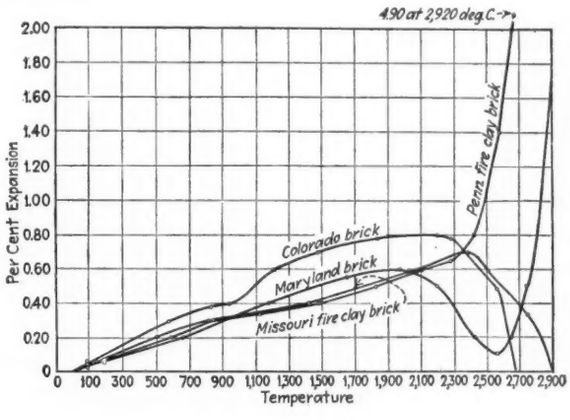


Fig. 2—Thermal Expansion of Firebrick

For a well-bonded, long-lived furnace wall the cement used in the laying up of the refractory brick must be of equal quality with the brick. The following outline of the desirable qualities of a cement indicate the properties necessary to accomplish this.

1. It must be about as refractory as the brick it binds together. Also, it should possess physical and chemical properties similar to those of the refractory.

2. It must be easy to mix, and stay suspended in the mortar box without settling and form a plastic, easily flowing and spreading body.

3. It must be free from fluxes, which are injurious to its refractoriness.

4. It must be free from expansion and contraction or a gas-tight joint will not be formed.

5. The initial cost should be reasonable. The cost of cement in many installations is equal to, if not more than, the cost of the brick.

6. It must have a large covering capacity—350 to 400 lb. should be an ample supply to lay 1,000 brick.

7. Under the action of heat it should form a strong solid body, knitting the whole structure together at working temperatures without fusion.

Table 3 shows the chemical composition of four air-setting cements which are available for laying up fire-brick.

FROM AMONG READERS' PROBLEMS

Conducted by

L. H. MORRISON

PREHEATING AIR WITH STEAM—*We are considering heating the air required for combustion with exhaust steam which is wasted during the summer. To what temperature could we expect to raise the air? The following are data which may be of service: Average temperature of air to heater, 60 deg. F. and the volume of air required per min. is 3,720 cu.ft.*

The heater in which we propose to heat the air is an Alberger closed type with 600 copper tubes of ¾ in. diameter and 6 ft. length. We waste to the atmosphere during the summer months about 54 lb. of steam per min. at 3 lb. back pressure.

From the amount of steam available, I contended that the air in passing through the tubes would be raised up to 210 deg. F. but it was suggested that the velocity of the air would be too great to permit the transfer of heat. V.A.

The total tube surface in the heater is $3.1416 \times \frac{0.75}{12} \times 6 \times 600 = 707$ sq.ft.

Assuming 210 deg. F. as the final air temperature the arithmetical mean temperature difference, with the inlet air at 60 deg. F. and the steam temperature of 220 deg. corresponding to 3 lb. back pressure becomes

$$\frac{(220-210)+(220-60)}{2} = 85 \text{ deg.F.}$$

Heat transfer from condensing steam to air should range around 2 B.t.u. per square foot per hour per degree temperature difference. Consequently the possible heat transfer in the 707 sq.ft. would be $707 \times 85 \times 2 = 120{,}190$ B.t.u. per hour. The 3,720 cu.ft. of air per minute will weigh $3{,}720 \times .0727 = 268$ lb., which makes the hourly flow equal to 16,080 lb. The specific heat at constant pressure is approximately 0.24 B.t.u. For each degree rise of the 16,080 lb., there will be required $16{,}080 \times 0.24 = 3{,}859$ B.t.u. To raise the air from 60 to 210 deg. F. will require $3{,}859 \times (210 - 60) = 578{,}850$ B.t.u.

Since the tube surface will transfer only 120,190 B.t.u. per hour, obviously the weight of air that can be heated to 210 deg. F. is $\frac{3{,}720 \times 120{,}190}{578{,}850} = 772$ cu.ft. per min.

To find the temperature to which the air can be heated, let it be assumed that the exit air temperature be X; then the mean temperature difference is

$$\frac{(220-X)+(220-60).}{2}$$

The heat transfer through the 707 sq.ft. of tubes, with 2 B.t.u. as the coefficient of heat transfer, becomes

$$\frac{(220-X)+(220-60)}{2} \times 707 \times 2.$$

The heat absorbed by the 16,080 lb. of air per hour will be $16{,}080 \times 0.24 (X - 60)$. Setting these two expressions as equal we have $16{,}080 \times 0.24 \times (X - 60) =$

$$\frac{(220-X)+(220-60)}{2} \times 707 \times 2.$$

Then X, the final air temperature, is 109 + deg. F. The 54 lb. of steam per minute is ample to heat the air. The greater the air velocity the greater will be the heat transfer.

▼

A Question for Our Readers

WE HAVE three 14x17 six-cylinder two-stroke-cycle crankcase-compression diesel engines on which the lubricating oil consumption is high. I assume that the excess oil is pulled up into the cylinder along with the scavenging air. Is it possible to install a baffle to prevent this? E.M.R.

Suitable answers from readers, if received promptly, will be paid for[1] when published.

▼

OPENING THE ROTOR CIRCUITS OF A PHASE-WOUND MOTOR—*Is there any objection to opening the rotor circuits of a wound-rotor motor when stopping the machine?* M.R.

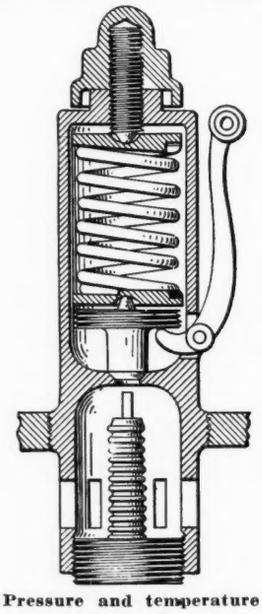
There is no objection to doing this after the motor has stopped, but the rotor circuits should not be opened before the stator. If the rotor circuits are opened before the stator, when the latter is disconnected from the line a high voltage will be induced in the motor's windings. This is caused by the high rate at which the flux decreases in the core iron when the rotor circuits are open.

With the rotor circuits closed, when the stator is disconnected from the line and the flux starts to decrease in the core iron, a current is induced in the rotor winding in a direction to prevent the flux change. As a result the flux decreases slowly and the high induced voltage is avoided. The value of the induced voltage with the rotor winding open may be two or three times normal. Although this may not be sufficiently high to break down the insulation, it is not advisable to unnecessarily subject the insulation to this stress. Normally the rotor resistors are permanently closed through the star connection and cannot be opened by the control. Unless there is some special reason for doing otherwise, the rotor circuits should be permanently closed through the external resistance.

—❖—

AVOIDING EXCESSIVELY HOT WATER—*In our hotel the warm water for the bathrooms is heated in a steam coil heater. We must install some control to hold the temperature to below 160 deg. F. Is there any kind of a relief valve that lets warm water spill out and cold water to enter when the heater becomes too hot?* C.V.T.

A pressure and temperature relief valve similar to that shown in the illustration may be placed on the heater. In addition to the pressure relief controlled by the spring, a sylphon bellows tube filled with a volatile liquid is placed below the valve disk. When the temperature increases beyond a predetermined point the sylphon expands and pushes the valve open to permit the escape of some of the hot water.



Pressure and temperature relief valve

A better control, however, would be a thermostatic valve on the steam inlet to the coils. The water temperature acting through the thermostat opens and closes the steam valve.

[1] As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fritz' *Refrigeration*; Rietschel-Brabbee's *Heating and Ventilation*; Annett's *Electric Elevators*.

ACTION OF TRAPS—*What are the principles upon which float, bucket and thermostatic traps work?* C.M.R.

In a float trap, the accumulation of condensation causes a float to rise and open the discharge valve, and the steam pressure then forces out the water; in a bucket trap, the water accumulates and spills over the edge of the bucket float, causing it to sink and open the discharge valve; in the thermostatic trap, the accumulated water cools and causes a tube or a pipe to contract, thus opening the discharge valve. After the water is discharged, the float, bucket, or thermostat closes the discharge valve and prevents escape of steam into the trap discharge line.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WE HAVE been greatly troubled with the electric lamps burning out in the hoist room and part way down the incline at our mine. The light circuit is run on knobs and cleats parallel with a 440-volt motor circuit. A 10-kva., 440/220 and 110-volt transformer supplies power to the lights in the hoist room and incline. The 115-volt lamps have been replaced with lamps for 125 volts, but these also burn out. What is causing this trouble and how can it be overcome? R.E.M.

THE INFORMATION given in R.E.M.'s question is not conclusive, but three possible causes present themselves. Presumably the 10-kva. lighting transformer is supplied from the circuit that feeds the hoist motor. If this is so the voltage drop on the feeder at full load should be checked. Also check the voltage on the 440-volt side of the lighting transformer when the hoist motor is running fully loaded and when it is disconnected. If the voltage is adjusted to give normal value at the motor when developing full load it is possible that the voltage is too high for the lamps when the motor is not running.

The simplest way to correct this trouble would be to run a separate feeder from the main distributing board to the lighting transformer, and adjust the transformer taps to give suitable lamp voltage. Variations in line drop in the motor feeder will then not affect the lamps. The fact that the trouble is experienced in the hoist room itself and part way down the incline bears out this theory. At the same time it suggests that the circuits supplying the lamps farther down the incline are a little on the small side, and that the more distant lamps are operating below their rated voltage.

The other two suggestions are that the trouble may be due to vibration from the hoist or that an exceptional long life is expected of the lamps. If the former is the case, a different type of lamp or the installation of cushioned sockets might remove the trouble. The manufacturers might have a more rugged type of lamp to offer. Failures in and near to the hoist room also fit in with this theory.

As regards lamp life, most lamps today are designed for a useful life of about 1,000 hr., it being considered that the falling off in efficiency of the lamps after this period more than offsets the replacement cost. If the lamps burn 24 hr. a day, 1,000 hr. represents only six weeks' service.

C. E. OLIVE, *Chief Engineer,*
Canadian Celanese, Ltd.
Drummondville, Que.

THE FIRST THING to do is to check the voltage of the lighting circuit. If power is supplied from a local plant the voltage may be excessive at times due to poor regulation of the prime movers. If the voltage is constant but high, moving the 440-volt transformer farther away may improve conditions.

Inspect the lamp circuit for vibration. If the lamps are rigidly supported on the incline structure vibration may be the cause of the trouble. This can be relieved by using flexible supports as shock absorbers. Check the circuit for possible contact between the 440-volt and 115-volt circuits. Fast-moving ropes may produce static electrical charges that affect the lamps. Also check for a defective transformer.

A. E. ELLIOTT.
Birmingham, Ala.

THE LIGHTING TRANSFORMER is no doubt supplied from a 440-volt power circuit which is affected by the starting and the overspeed braking action of the 50-hp. hoist motor. An unstable voltage has a bad effect on the life of lamps, and is probably the cause of the trouble. I suggest that the lighting transformer be disconnected from the power circuit and another 440-volt circuit run for lights only from the main distribution transformer bank. A load of 5,000 watts is not excessive on a single-phase 110-volt line for 2,000 ft. using No. 2 wire, in which case the lighting transformer could be moved outside the building.

I have had success in tunnel construction work with a three-phase 110-volt line. The lamps gave good service for a distance up to 6,000 ft., when distributed evenly between the three phases, using No. 4 wire. The three-wire 110- and 220-volt installation gave trouble when the neutral shorted with the 220-volt leg. This applied 220 volts across the other half of the circuit long enough to burn out the lamps adjacent to the short, when the trouble occurred some distance away from the fused switch. HAZEN F. WILLETT.
Concrete, Wash.

AT LEAST three different conditions would cause R.E.M.'s trouble: vibration, mutual inductance and line surges. Vibration may be caused by the rapidly changing air pressure due to a hoist or elevator moving in the hoistway, or it may be set up by the machinery. The best way to check for vibration is to replace one of the lamps with a carbon-type and watch its filament.

Mutual inductance occurs between parallel lines that are run open, and it can be determined by installing a voltmeter (recording type preferred) on the lighting line. By running the hoist at different loads, if mutual inductance exists between this power line and the lighting circuit the voltmeter will show surges while the hoist is in operation. This fault can be corrected by transposing the lighting circuit at different intervals in the run of the circuit, or by installing this circuit in iron conduit.

Line surges are caused by starting the hoist, or other motors, which draws a large starting current and which are on the same circuit as the lighting transformers. This can also be checked with a voltmeter (as in the preceding case), but the surge will be momentary when the motor is started. This fault can be remedied by isolating the transformer circuit. C. O. MILLER.
Crockett, Calif.

IT IS PROBABLE that the motor driving the hoist runs above synchronous speed while operating in the lowering direction. Because of the regenerative character of the induction motor it generates a voltage higher than 440 volts. Since the 110-volt circuit is connected through the transformer to the 440-volt circuit supplying the motor, any increase in voltage caused by regeneration would increase the voltage of the lighting circuit.

A motor driving a load of this type should be connected to a load brake to prevent overspeeding caused by the load overhauling the motor. If it is already equipped with a load brake, investigation would probably prove the brake to be faulty. A remedy for this condition would be to connect a voltage regulator between the transformer and the lighting circuit or to connect the lights to a transformer independent of the motor circuit. HOWARD ELY.
Sewaren, N. J.

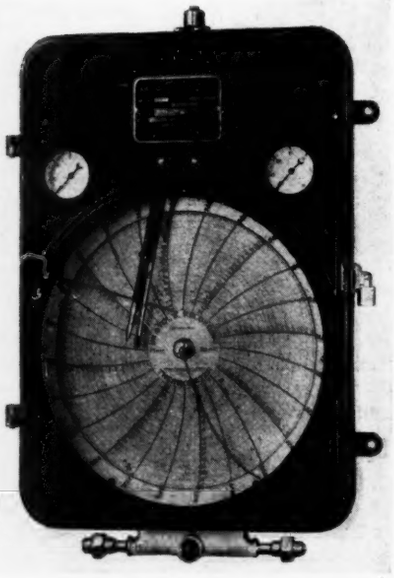
WHAT'S NEW IN PLANT EQUIPMENT

Air-Operated Recorder Controller Employs Free Vane Floating Between Two Air Streams

IN THE NEW LINE of air-operated recording controllers, put out by the Bristol Company, Waterbury, Conn., a "Free Vane" is attached to and actuated by a measuring element of a temperature or pressure recording system and moves between two air jets with stream lines coinciding placed opposite each other. In passing into these air streams, the "Free Vane" varies the amount of air which escapes from the jets, thus effecting control.

The arrangement and design of the two jets and the free vane are such that the vane floats between two equal air streams at right angles to its motion, hence the position and movement of the measuring elements are not affected.

Referring to the diagram, air at 15 lb. pressure is admitted through connection *A* and carried through filter *B*, one branch leading to an indicating gage *C*. The other branch supplies air to the control system. This supply branch in turn divides into two branches, one passing through an orifice *D* supplying the elastic element *E* and then through a connecting line to the opposing jets *F* and *G*. The other branch supplies air to the pilot valve *H* and through the pilot valve to the indicating gage *J* and outward to the diaphragm motor valve *K*.



Bristol air operated recording controller

The air which enters through orifice *D* is dissipated through jets *F* and *G*. The amount which may be dissipated through these jets depends upon the position of the free vane *L*. This vane, being directly attached to an elastic element *M* of the hollow helical type, is moved by changes in the temperature at

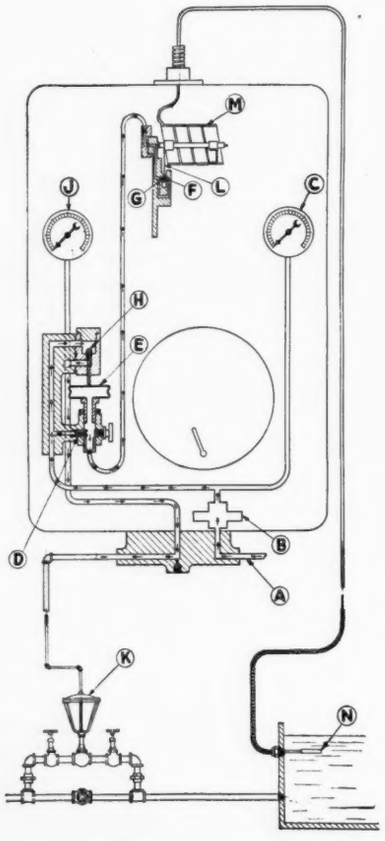


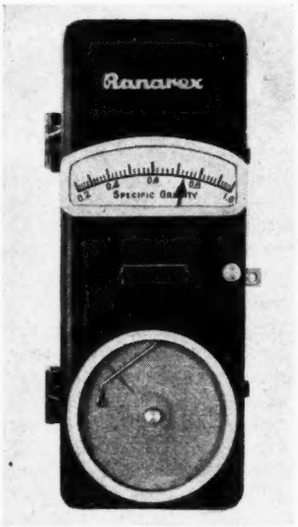
Diagram showing arrangement of operating mechanism

the sensitive bulb *N* in the bath. The changing amount of dissipated air at jets *F* and *G* produces a pressure change on the elastic element and a consequent deformation which operates pilot valve *H*, admitting more or less air to the top for operating the diaphragm motor valve *K*. The elastic element *M* also carries the recording penarm.

The controller is furnished with inverted penarm and fountain pen as standard equipment and is available for wall or flush mounting. It is furnished as a single or two-pen instrument in combination of pressure or temperature and has a pressure range up to 1,500 lb. and temperature range up to 1,000 deg. F. using 12 in. charts. Temperature measuring systems may be either vapor or gas filled, depending on the operating temperatures encountered.

New Specific Gravity Indicator and Recorder

A NEW MODEL of its Ranarex specific gravity indicator and recorder is announced by the Permutit Company, 440 4th Ave., New York, N. Y. The same principle of operation has been retained but the design has been simplified and the machine made more compact. The



Improved Ranarex specific gravity recorder

indicating and recording mechanism is attached to one plate and the driving mechanism, including the motor, to another. Both plates may be removed without the use of tools by loosening a few wing screws.

The humidifier is an integral part of the machines and the passages connecting the humidifier compartments and the measuring chambers are cast into the body and rear chamber door. This eliminates the pipes connecting the humidifier and measuring chambers used on the older model machine. Upon removing the rear chamber door, all gas channels are opened for inspection over their entire length.

Bakelite impellers, impulse wheels, separating plate, etc., replace similar parts of cast aluminum on the old model. The machine is enclosed in a dust-proof cast aluminum casing and is available for wall or flush panel mounting.

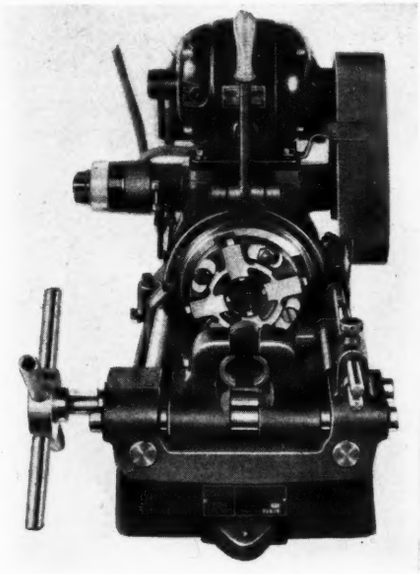
The standard scale on the new model machine is graduated from 0.2 to 1.0 specific gravity in place of the 0.35 to 1.0 range on the strip chart model. The scale is 9 in. wide and the circular charts are 8 in. in diameter. The recording mechanism is driven either by a spring driven clock or an electric clock where alternating current is available.

In addition to the model illustrated, a special recorder for the control of Butane-air mixing has been developed. This machine has a specific gravity range of 1.0 to 1.2 and a superimposed adjustable scale graduated in B.t.u. per cubic foot, corresponding to the heating value of the Butane-air mixtures, thus giving both readings on the same machine. Other scale ranges are available.

Pipe Machine With Rotary Die Head

AS A COMPANION to its original "Tom Thumb" pipe and bolt machine, the Oster Manufacturing Company and Williams Tool Corporation, Cleveland, Ohio, have announced the new rotary-die head machine illustrated.

The regular pipe capacity of the new machine includes all sizes from ½ to 1¼ in. with an extra capacity down to and including ⅛ in. The regular bolt capacity is ⅜ to 1¼ in. with an extra capacity of ¼, ⅝, 1⅜ and 1½ in. It can be furnished either as a bolt threader or



Oster pipe and bolt machine

with special equipment to handle nipples.

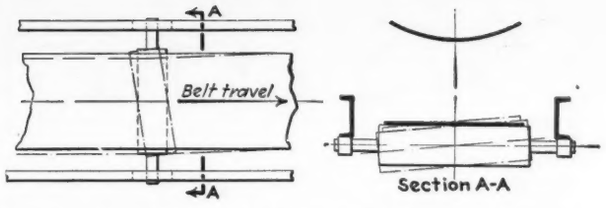
The machine is equipped with a stock-stop and an automatic trip which opens the die head when the thread has reached any desired length. A hand trip is also supplied. Driving power is furnished by the ½ hp. universal, reversible motor.

Belt Trainer for Return Strand of Belt Conveyors

DESIGNED to protect the return strand of a belt conveyor from edge wear and other damage caused by crooked running, the belt trainer illustrated brought out by the Robins Conveying Belt Company, 15 Park Row, New York, N. Y., is made in all belt widths from 12 to 48 inches.

It consists of a tubular roller mounted upon a single antifriction bearing at its center, the bearing being internally pivoted upon a fixed swivel pin located on the center line of the conveyor and inclined forward about 30 deg. This permits the roller not only to rotate freely on the bearing but also to rock about the pivot.

In service the action of the pulley, if the belt tends to run to one side, is to become skewed with relation to the belt and cause the belt to move back to the conveyor center line. It is pointed out by the manufacturer that the pulley does not oscillate continually as might be expected but automatically assumes a stable position. Thus the belt is made to find its central position and runs true.



Pivoted pulley causes belt to find its central position and run true

Under normal conditions the use of a belt trainer in place of every eighth standard return idler (or about every 80 ft.) will give satisfactory operation and in adverse conditions in place of every fifth roller, about every 50 ft. The trainer pulleys are interchangeable with the Robins standard return idlers and may be modified where necessary to suit other equipment.

Self-Contained Coal Burner

A NEW DESIGN of automatic, self-contained coal burner specially adapted to utilize the lower-grade and smaller-size coals, from 1½-in. screenings down, has been developed recently by the Aerio Coal Burner Sales Corporation, 418 Bagley St., Dearborn, Mich. The machine, it is claimed, will give good results with screenings, slack, and other inferior fuels and Eastern or Western coals are burned with equal facility, without regard to ash or sulphur content.

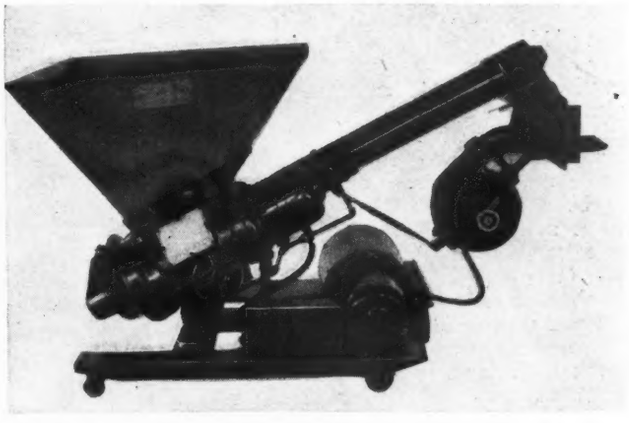
By a screw feed and an air blast the fuel is forced into the furnace. The finer particles of coal burn in suspension, while the coarser pieces settle and burn on a pin-hole grate provided with forced draft. Combustion then is somewhat similar to that of powdered coal, except that the coal particles are larger. The grates are cleaned in the regular way.

At the present time the machine is being made in two sizes, one with capacity to burn 200 to 800 lb. of coal per hour, and the other 800 to 2,000 pounds. Thus boilers of 1,500 to 5,000 sq.ft. of surface may be served.

Reference to the illustration will show that the entire burner unit is mounted on a wheeled truck running on rails. Thus the unit may be moved back from the furnace front, although a width ranging from 16 to 20 in. will fit easily between the cleanout doors at either side of a furnace. The burner also is pivoted so that the feeder head, appearing at the right in the illustration, may be moved up or down to correspond to the elevation of the opening into the furnace.

From the storage hopper the fuel is forced to the feeder head by a screw conveyor, motor driven through a variable-speed reducer running in oil. From the feeder the fuel drops by gravity onto a 45-deg. deflecting plate leading to a grooved casting that guides the coal into the furnace. Under the plate is a blast of air supplied by the motor-driven fan shown attached to the feeder head. The air blast carries the coal into the furnace, where the finer particles burn in suspension and the larger pieces assemble on the pin-hole grate, supplied with forced draft by the fan mounted directly on the truck.

In operation the burner is automatic, as a mercoid control starts and stops the equipment in accordance with the steam pressure. For any particular fuel, adjustments of the screw and fan speeds are established by hand and remain constant. Either alternating-current or direct-current motors may be used.



Aerio coal burner a self-contained unit

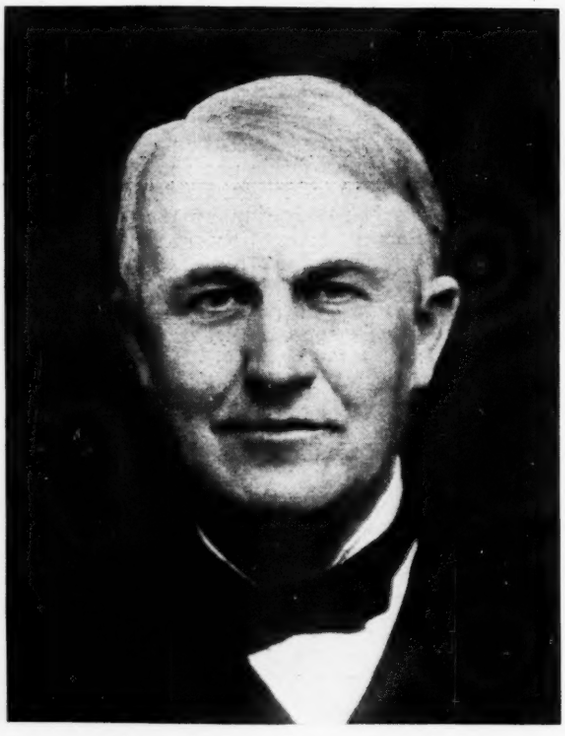
Claims made for the burner are that it is easy to install, requiring no foundation nor excavation. With no disturbance of the fuel bed clinker troubles are minimized. The hottest part of the furnace is above the grates, the latter being maintained below fusion temperatures by the forced blast.

NEWS of the FIELD

Thomas Alva Edison

THOMAS ALVA EDISON, world-famous inventor and pioneer in the electric power field, died on Oct. 18, at his home in Menlo Park, N. J., after an illness of several months' duration. He was 84 years old.

Known and honored throughout civilized humanity for his many inventions and scientific discoveries, Thomas Edison was born on Feb. 11, 1847, in Milan, Ohio. His family moved to Port Huron, Mich., in 1854, where it is said young Edison attended school for three months and was consistently at the foot of the class. At the age of ten he started a chemical laboratory in the cellar of his home, and two years later he became a newsboy and "candy butcher" on Grand Trunk trains running between Port Huron and Detroit to obtain the money necessary for carrying on his experiments. He installed a laboratory in the baggage car of the train. In 1862 he bought an old printing press, set it up in the baggage car and commenced publication of his own newspaper, *The Weekly Herald*, which consisted of news items gleaned from the railway telegraph. During that same year he saved from death the young son of J. U. Mackensie, station agent at Mount Clemens, Mich., and out of gratitude for this act the father taught Edison telegraphy.



From 1863 to 1869 Edison worked on improvements to telegraph and related apparatus, and on June 1, 1869, received his first patent for a vote-recording device. As there was little demand for the recorder, Edison went to New York and bent his energy to perfecting the stock ticker, inventing the "Universal" ticker, which he sold in 1870 for $40,000, the first money for any of his inventions. With this sum he opened a manufacturing shop in Newark, N. J., where he made various types of telegraph instruments. In 1871 he assisted Sholes, the inventor of the typewriter, to make the first successful working model, and five years later he gave up manufacturing, started a laboratory in Menlo Park and devoted his entire time to research.

In 1876 Edison invented the carbon telephone transmitter that made telephony a commercial possibility, and invention of the phonograph followed a year later. About this time he became interested in electric illumination and turned his whole attention to the development of an incandescent lamp. The invention was perfected on Oct. 21, 1879, when the first lamp embodying the principles of the modern incandescent lamp was put in circuit and maintained its incandescence for over 40 hours.

Edison immediately turned to the commercial introduction of the electric lamp, and from 1879 to 1882 he invented radical improvements in the construction of generators, regulating devices and distribution systems. At the same time he constructed one of the first electric railways for freight and passengers and opened the first incandescent lamp factory at Harrison, N. J. On Sept. 4, 1882, he placed in operation the first central station in New York City for the distribution of light, power and heat. This historic station at 257 Pearl St. contained six 125-hp. engine-driven dynamos, supplied with steam at 120 lb. pressure by four water-tube boilers.

During 1881 to 1887 Edison perfected a system of wireless telegraphy for use between moving trains and railway stations. He invented a motion picture camera and projector in 1891, and from that year until 1910 he worked on the development of the magnetic ore separator, the alkaline storage battery, processes for the production of Portland cement and the universal electric motor. In 1912 he introduced the Kinetophone or talking motion picture. With the advent of the World War, Edison turned his attention to the production of benzol, aniline oil and other chemicals formerly imported in large quantities. He succeeded in discovering how to make these chemicals.

As president of the Naval Consulting Board Edison devoted a large portion of his time during the war years to the service of the nation. He worked on devices for the detection of submarines and airplanes, turbine heads for projectiles, camouflaging ships and many other major problems. At the close of the war he returned to his plant at Orange, N. J., and performed a prodigious amount of work in reorganizing production, experimenting on new devices, processes and improvements. Lately, until his recent illness, he had been devoting a great deal of his time to investigations looking to the production of rubber from plants grown in the United States, to meet possible national emergencies.

A man of tremendous vitality of both body and brain, Edison retained his faculties extremely well to advanced age. Since 1919 he had filed 44 applications for patents and 40 patents had been issued to him in that period. Altogether, about 1,150 patents were issued to Edison, who was unquestionably America's greatest inventor.

Program Announced for A.S.M.E. Annual Meeting

ANNOUNCEMENT was made Oct. 22 of the program for the annual meeting of the American Society of Mechanical Engineers, which will be held in the Engineering Societies Building, New York City, from Nov. 30 to Dec. 4, inclusive. Among the many papers and reports scheduled for the technical sessions, the following are of particular interest to engineers in the power field:

"Ford Motor Company's 1,200-Lb. Steam Plant Installation," A. R. Smith and H. B. Hanson; "Characteristics of a High-Pressure Series Steam Generator," A. A. Potter, H. L. Solberg and G. A. Hawkins; "Once-Through Series Boiler for 1,500 to 5,000 Lb. Pressure," H. J. Kerr; "Performance of Modern Steam Generating Units," C. F. Hirshfeld and G. U. Moran; "Solubility of Calcium Salts in Boiler Water," F. G. Straub; "Influence of Inlet Boxes on the Performance of Induced-Draft Fans," L. S. Marks and E. A. Winzenburger.

"Determination of Carbonate, Hydroxide and Phosphate in Boiler Waters —Progress Report of Sub-Committee No. 8," W. C. Schroeder and C. H. Fellows; "Foaming and Priming of Boiler Water," C. W. Foulk; "The SO_4/CO_3 Ratio for the Prevention of Sulphate Boiler Scale," E. P. Partridge, W. C. Schroeder and R. C. Adams, Jr.; "Small Marine Diesel Installations," L. B. Jackson; "United States Navy Diesel-Engine Requirements," Commander Holbrook Gibson; "Fluxing of Ashes and Slags as Related to the Slagging-Type Furnace," W. T. Reid.

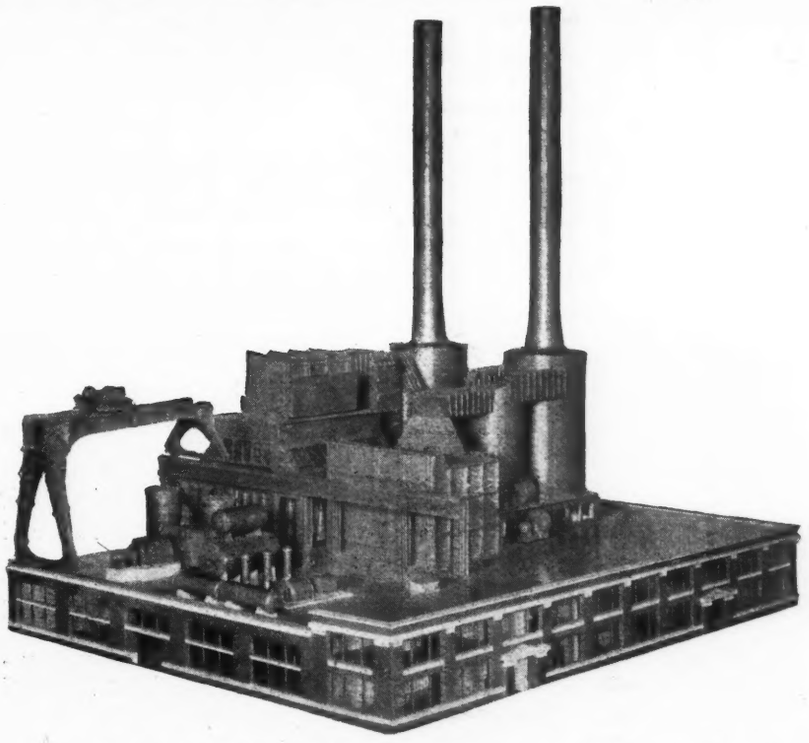
"Leakage Loss and Axial Thrust in Centrifugal Pumps," A. J. Stepanoff; "Turbulence in Centrifugal Pumps," J. W. Macmeeken; "Hydraulic Butterfly Valves," R. L. Mahon; "Piezometer Investigation," C. M. Allen and L. J. Hooper; "Flow of Steam Through Square-Edge Orifices in 4-In. Line," W. W. Frymoyer and A. Herschel; "Study of Primary Metering Elements in 3-In. Pipe," S. R. Beitler, Paul Bucher and T. C. Barnes; "Pressure Distribution in the Oil Films of Journal Bearings," S. A. and T. R. McKee.

Acetylene Association to Hold Meeting in Chicago

FEATURING a program timed to the present needs of industry, the 32nd annual convention of the International Acetylene Association will be held at the Congress Hotel in Chicago, Ill., on Nov. 11 to 13, inclusive. Topics of vital interest to the welding industry will be covered by leaders in the various fields. At the same time ample time will be allowed for open discussion by those attending the convention.

Among the subjects scheduled are: "Business Prospects for 1932," "Welding and Its Future," "Revised A.S.M.E. Boiler Code," "Training Welders," "Testing Welds," "Aircraft Welding," "Railroad Welding," "Marine Welding," "Automobile Welding," "Welded Piping Design," "Pipe-Line Welding," "Welding the New Alloys," "Painting, Enameling and Lacquering Welded Joints," "Engineering Education in Welding," and "Industrial Acceptance of Welding."

FIRST OUTDOOR MERCURY PLANT



How the new 20,000-kw. outdoor mercury-vapor power plant of the General Electric Company at Schenectady, N. Y., will look is shown by this model. Differing from the Hartford installation, the turbine will be located at a low level and the mercury will be pumped into the boiler drum instead of flowing by gravity. This will be the first large outdoor plant with the largest mercury-vapor unit

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Central Iron Company Adds Two Waste-Heat Boilers

INSPIRED by the success of the 5,000-sq.ft. fire-tube boiler operated from waste gases from one of its open hearth furnaces, installation of which was completed early in May, this year, Central Iron & Steel Company, Harrisburg, Pa., is now completing the installation of two duplicate units.

The boilers which furnish steam for operation of rolling mill engines are 22 ft. long and 9 ft. in diameter, each equipped with 470 tubes 2½ in. in diameter. Large fans exhaust the open hearth gas through the boilers at high velocity while the steam is carried to the mill engines through a recently constructed 12-in. steam line approximately 2,450 ft. long.

Prior to the first installation the company had successfully employed nine waste-heat boilers of 1,500 sq.ft. each.

Michael I. Pupin Awarded John Fritz Medal for 1932

THE JOHN FRITZ GOLD MEDAL, highest of American engineering honors, has been awarded for 1932 to Dr. Michael I. Pupin of Columbia University for his achievements as "scientist, engineer, author, inventor of the tuning of oscillating circuits and the loading of telephone circuits by inductance coils," it was announced last week.

Dr. Pupin is professor of electromechanics and director of the Phoenix Research Laboratory at Columbia. Among engineers and scientists he is widely known for his researches and inventions in connection with long distance telephone lines, and for his advanced work in the passage of electricity through gases, electrical resonance, electrical wave transmission over long conductors, and many other scientific subjects. Among his best known writings is an autobiography, "From Immigrant to Inventor."

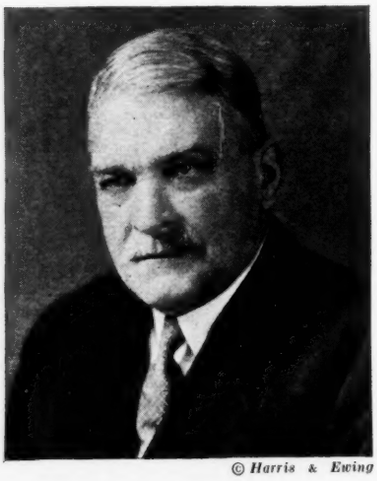
He was born a Serb in a province of Hungary, Oct. 4, 1858. He came to America as a boy and after many courageous struggles won an opportunity for an education. He was graduated from Columbia in 1883.

Dr. Pupin is a past president of both the American Institute of Electrical Engineers and the American Association for the Advancement of Science.

Dr. Stratton of M. I. T. Dies Paying Tribute to Edison

A FEW MINUTES after he had finished dictating a tribute to his friend, Thomas A. Edison, Dr. Samuel Wesley Stratton, chairman of the Massachusetts Institute of Technology corporation, died of a heart attack Oct. 18 at his home in Boston, Mass. He was 70 years old.

Apparently in the best of health, despite his advanced years, Dr. Stratton, who was the founder and first



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director of the United States Bureau of Standards, had returned to Boston a few days before Edison's death from the Faraday celebration in England.

Dr. Stratton, the son of a farmer, was born at Litchfield, Ill. Farm life did not interest him. He preferred to tinker with machinery and before he was of age he was earning full wages as a mechanic. This facility enabled him to work his way through the University of Illinois, where he obtained his mechanical engineering degree in 1884. He won an appointment as instructor in mathematics at the University of Illinois. He advanced steadily, and when he left the university in 1892 he was professor of physics.

The Bureau of Standards really had its beginnings in an idea of Dr. Stratton's while he was teaching chemistry and physics. He saw the need for some central department which would have the custody of standards used in scientific investigation. Dr. Stratton brought this idea to the attention of Lyman Gage, then Secretary of the Treasury, in 1900. Mr. Gage asked Dr. Stratton to draft the bill for the establishment of what was to become known as the National Bureau of Standards, and he pressed the matter until Congress acted favorably on the proposal in 1901.

Dr. Stratton became the first head of the bureau in 1901. At that time he was established in temporary quarters near the Capitol and he had about twenty employees. When he resigned to become president of the M.I.T. in 1923 the bureau had become the foremost research institution in the country, with fourteen permanent buildings and 900 employees.

COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

International Acetylene Association. Annual convention at the Congress Hotel, Chicago, Ill., Nov. 11-13. Secretary, A. C. Morrison, 30 East 42d St., New York City.

National Association Practical Refrigerating Engineers. Annual convention and exhibition at the Municipal Auditorium, Houston, Tex., Nov. 10-13. Secretary, Edward H. Fox, 435 North Waller Ave., Chicago, Ill.

Seventh Annual Conference on Welding, to be held by the Engineering Extension Department of Purdue University at Lafayette, Ind., Dec. 10-11. Professor in charge, W. A. Knapp, Engineering Extension Department, Purdue University, Lafayette, Ind.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

A. J. Sayers, Coal-Handling Engineer, Dies Suddenly

ALBERT JEFFERSON SAYERS, head of the coal tipple and coal washery department of the Link-Belt Company, died suddenly Oct. 11 at his home, 7121 Eggleston Ave., Chicago, Ill. He was well known throughout the coal industry, having designed and built numerous plants for the handling and preparation of coal in all parts of the country, and he was recognized as one of the leading designers of this type of equipment.

Born at Troy, Ohio, on Sept. 10, 1870, and educated at the University of Illinois, Mr. Sayers was graduated in the class of 1895. He joined the Link-Belt organization in 1899, and in the 32 years of his affiliation with that company he became a leading factor in the field of mechanical handling, screening and washing coal. He was a member of the American Society of Mechanical Engineers, the manufacturers division of the American Mining Congress and other engineering organizations. He was a brother of W. W. Sayers, chief engineer of the Link-Belt Company.

Conrad N. Lauer Elected President of A. S. M. E.

RESULTS of the election of officers for 1932 were announced Oct. 22 by the American Society of Mechanical Engineers. The new officers, who will be installed at the annual meeting in December, are: President—Conrad N. Lauer, president of the Philadelphia Gas Works; Vice-Presidents—Robert M. Gates, vice-president of the Superheater Company, New York; Charles M. Allen, professor of hydraulic engineering at Worcester Polytechnic Institute; Frederick H. Dorner, mechanical engineer, Milwaukee; William B. Gregory, professor of experimental engineering at Tulane University; Managers —Alexander J. Dickie, editor of *Pacific Marine Review,* San Francisco; Eugene W. O'Brien, editor of *Southern Power Journal,* Atlanta; Harry R. Westcott, president of Westcott & Mapes, Inc., New Haven.

Personals

HAROLD A. EVERETT, professor of thermodynamics at Pennsylvania State College since 1922, has been appointed head of the department of mechanical engineering at Penn State, to succeed Professor ARTHUR J. WOOD, who was killed by a motorcycle last April.

S. B. FLAGG, fuel engineer of the Electric Bond & Share Company and representative of the National Electric Light Association on the Sectional Committee on Classification of Coals of the American Standards Association, has been elected vice-chairman of the committee, succeeding W. R. ADDICKS, deceased. Other recent appointments to this committee include W. CULLEN MORRIS, vice-president and chief engineer of the Consolidated Gas Company, New York, and T. A. HENDRICKS, geologist of the United States Geological Survey.

L. P. BRECKENRIDGE, professor emeritus of mechanical engineering of Yale University, left on Oct. 16 with Mrs. Breckenridge for a winter in Italy. Professor Breckenridge plans to spend most of the time in Naples and expects to return home the early part of May.

E. W. LLOYD, vice-president of the Commonwealth Edison Company, Chicago, has been made chairman of a committee to arrange for the participation of the electric light and power utilities in the Chicago World's Fair to open in 1933. The committee was named by the National Electric Light Association.

CHARLES P. MILLS, formerly director of the chrome alloy department of the General Alloy Company and one of the leading authorities on heat- and corrosion - resisting chrome-iron and chrome-nickel castings, is now chief engineer of Empire Steel Castings, Inc., Reading, Pa.

Business Notes

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces that orders received for the first nine months of this year amounted to $202,700,016, compared with $267,651,832 for the corresponding period of 1930. Sales billed totaled $206,138,967, compared with $287,886,541, and profit available for dividends amounted to $30,753,850, compared with $42,518,708 for the first nine months of last year.

INTERNATIONAL-STACEY CORPORATION, Columbus, Ohio, announces the purchase of all stock of the Stacey Manufacturing Company, Cincinnati. Col. Carmi Thompson, president; A. A. Ranshaw, vice-president; H. M. Runkle, secretary and treasurer; and E. J. Baechle, assistant secretary and treasurer, will head the Cincinnati group, which will be known as the Stacey Gas Construction Division of International-Stacey Corporation.

GENERAL WATER TREATMENT CORPORATION, New York City, through stock ownership has acquired the business of the American Zeolite Corporation, Birmingham, N. J. The business will be operated by the American Zeolite Corporation as a unit of the General Water Treatment Corporation with offices at 440 Fourth Ave., New York.

UNION CHAIN & MANUFACTURING COMPANY, Sandusky, Ohio, announces the appointment of C. H. Upson, 1012 Traction Building, Cincinnati, Ohio, as its representative in that territory. The appointment of Mr. Upson, who has had wide experience in the field of power transmission, elevating and conveying machinery, is in keeping with the company's expansion program begun more than a year ago.

WESTINGHOUSE LAMP COMPANY, New York City, has turned over the Westinghouse Lighting Institute in Grand Central Palace to the Electrical Association of New York, without cost, to further the cooperative industry program of the association. Negotiations toward this end have been in progress for some time by Clarence L. Law, president of the Electrical Association, who stated that hereafter the Lighting Institute will be cooperatively maintained and operated as an industry educational and market development center by the association.

MUNDET CORK CORPORATION, New York City, announces the removal of its office from 461 Eighth Ave. to new and larger quarters on the 29th floor of the Nelson Tower at 450 Seventh Ave., New York City.

WIDGER & MILLER COMPANY, Boston, Mass., announces that E. M. Monteith has joined its staff. Mr. Monteith was formerly sales engineer for the Walworth Company of Boston.

How's Business?

ALL THE crucial questions requiring large-scale constructive action to speed recovery remain in a state of suspension this week, according to *The Business Week*, Oct. 28. Emergency remedies applied to the banking situation and offered to the railroads by the rate decision, as well as provisional arrangements which have improved the European political and financial picture, have temporarily relieved the tension. Most encouraging is the strengthening of key commodities, probably in anticipation of ultimate inflation as the only exit from our economic dilemma. Our index has relapsed to a lower level, but still holds above the deadline of 70 per cent of normal that seems to have established the limit of business decline in this depression.

Power production by public utilities for the week ended Oct. 17 was 1,656,051,000 kw.-hr., or 4.2 per cent below the corresponding period last year, according to N.E.L.A. figures.

Trade Catalogs

STEAM-GENERATING UNITS—The first catalog to describe fully the Riley-Badenhausen steam-generating units has just been issued by the Riley Stoker Corporation, Worcester, Mass. Besides complete units, the catalog covers water-tube boilers, superheaters, integral economizers, air preheaters, water-cooled furnaces and steel-clad insulated settings. It is exceptionally well illustrated with photographs, line and wash drawings in color, and contains an interesting section depicting many steps in the manufacture of the equipment.

FANS—The design and construction features of the new "Design 4 Silentvane" fan are described and illustrated in Bulletin No. 381 just issued by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. Performance charts and tables are also included in the bulletin.

WELDING—Detailed information on the different styles of welding and cutting torches, units and gas-pressure regulators manufactured by the Torchweld Equipment Company, 224 North Carpenter St., Chicago, Ill., is given in a new illustrated catalog, recently issued by the company.

BELTING, PACKING—Catalog 31 describes and illustrates the various lines of transmission, conveyor and elevator belting; piston and valve packing; hose and other mechanical rubber goods manufactured by the Pioneer Rubber Mills, 345-53 Sacramento St., San Francisco, Calif. Tables of sizes and prices are included, together with useful engineering information.

GAS ENGINES—Two new bulletins describing and illustrating natural gas engines have just been issued by the Clark Bros. Company, Olean, N. Y. Bulletin No. 200-48 covers natural gas engines for industrial plants, pumping plants and refineries, while Bulletin No. 200-49 is devoted to natural gas engines for ice plants, cold-storage and dry-ice plants.

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Fuel Prices

FUEL OIL

Boston (Oct. 16) Tank-car lots, f.o.b. 12@14 deg. Baumé, 2.86c. per gal.; 28@32 deg., 4.8c. per gal.

New York—(Oct. 22) Industrial use, f.o.b., per barrel of 42 gal.: Bunker C, 60c., terminal; Diesel, $1.30, refinery.

Tank-wagon delivery, per gal.: No. 1 (36@40 deg.), 8c.; No. 2 (32@36 deg.), 6.5c.

Philadelphia—(Oct. 14) Industrial use, f.o.b., per bbl. of 42 gal.: Bunker C, 70c.; Diesel, $1.40.

Tank-wagon delivery, per gal.: No. 1, 7.5c.; No. 2, 6c.

Pittsburgh—(Oct. 14) Industrial use, f.o.b. local refinery, 36@40 deg., 2.5c.@2.75c. per gal.

Cincinnati—(Oct. 20) Industrial use, f.o.b., tank cars, per bbl. of 42 gal., $1.25.

Tank-wagon delivery, per gal., 6.5c.

Chicago—(Oct. 14) Tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. of 42 gal.: 18@22 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5c. per bbl.; 28@30 deg., 37.5c. per bbl.

St. Louis — (Oct. 14) Tank-car lots, f.o.b. St. Louis: 24@26 deg., $1.02 per bbl. of 42 gal.; 26@28 deg., $1.095 per bbl.; 28@30 deg., $1.195 per bbl.; 30@32 deg., $1.245 per bbl.; 32@36 deg., gas oil, 2.776c. per gal.; 36@38 deg., distillate, 3.151c. per gal.

Dallas—(Oct. 17) Industrial use, f.o.b., tank cars, 22@26 deg., per bbl. of 42 gal., 60c.

Gas oil, 34@36 deg., f.o.b., per bbl., 84c.

COAL

Bituminous	At Mine, for Shipment to	Price per Net Ton
Clearfield, mine-run....	New York.	$1.50@$1.75
Pittsburgh, mine-run...	Pittsburgh.	1.20@ 1.50
Pittsburgh, st. slack...	Pittsburgh.	.60@ .70
W. Ky., mine-run.....	Louisville..	.85@ 1.30
W. Ky., slack.....	Louisville..	.35
Fairmont, mine run....	Fairmont..	.90@ 1.10
Fairmont, slack.....	Fairmont..	.50@ .85
Smokeless, mine-run...	Cincinnati.	1.75@ 2.00
Smokeless, slack.....	Cincinnati.	.35@ .75
Kanawha, mine-run....	Cincinnati.	1.00@ 1.25
Kanawha, nut-slack...	Cincinnati.	.35@ .50
Smokeless, mine-run....	Chicago...	1.75@ 2.00
Smokeless, slack.....	Chicago...	.40@ 1.00
Harlan, Ky., slack.....	Chicago...	.60@ .90
Franklin, Ill., mine run	Chicago...	2.15
Franklin, Ill., screen....	Chicago...	1.10@ 1.60
Ind. 5th Vein, m.-r....	Chicago...	1.20@ 1.75
Standard Ill., mine-run	St. Louis...	1.30@ 1.50

Anthracite	At Mine, for Shipment to	Price per Net Ton
Buckwheat.....	New York.	$3.25
Rice.....	New York.	1.75@ 1.85
Barley.....	New York.	.90@ 1.40

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., San Francisco—State Board of Harbor Commissioners, Ferry Bldg., is having plans prepared for addition to pre-cooling plant at China Basin. Estimated cost $500,000. F. G. White, Ferry Bldg., is engineer.

Calif., San Jose—Santa Clara Valley Water Conservation District, plans an election Nov. 17 to vote $6,000,000 to finance construction of five earth fill or earth and rock dams including installation of three pumping plants, one power plant, etc.

Calif., Sawtelle—Veterans Administration, 764 Arlington Bldg., Washington, D. C., will receive bids until Nov. 20, for addition to Wadsworth Hospital, Veteran's Administration Home including steam heating and ventilation systems, elevators, etc. here. Estimated cost $550,000. L. H. Tripp, Palo Alto, is engineer.

Colo., Colbran—Plateau Valley Light & Power Co., has been granted permit by Utilities Commission, for the construction of a power and light plant to serve towns of Colbran, Molina, Mesa and Plateau City. Estimated cost $35,000

Ill., Decatur—City plans an election in late fall to vote $275,000 bonds for rehabilitation of waterworks plant including new boilers and pumps. M. P. O'Brien, City Hall, is engineer.

Ind., Knightstown—Childrens Home, will receive bids until Nov. 4, for the construction of a waterworks plant including pumping equipment, tank on tower, etc., at Indiana Soldiers and Sailors Children's Home. Estimated cost $40,000. J. M. Rotz Engineering Co., 704 Merchants Bank Bldg., Indianapolis, is engineer.

Ind., Newcastle—Epileptics Village, will receive bids until Oct. 30, for the construction of a new heating plant building including brick chimney. Estimated cost $50,000. Foltz-Osler & Thompson, 1037 Architects and Builders Bldg., Indianapolis, are architects. Bevington Williams Inc., 1139 Knights of Pythias Bldg., Indianapolis, are engineers.

Ind., Petersburg — Petersburg Water Co. awarded contract for the construction of a pumping plant and filtration plant in connection with waterworks to Brown & Mick, 1020 East Michigan St., Indianapolis. Estimated cost $80,000.

Ind., Speedway—Town will soon award contract for improvements and additions to water system including one 500 g.p.m. direct connected centrifugal pumping unit, or one 500 g.p.m. electric deep well turbine pumping unit both with automatic control equipment. Estimated cost $50,000.

Ia., Cedar Falls—Bd. of Education, W. H. Gemmill, Secy., Capitol Bldg., Des Moines, awarded contract for equipment for new heating and power plant at Iowa State Teachers College to Tapager Construction Co., Albert Lea, Minn. $50,000.

Kan., Chanute—Kansas Communities Gas Co., W. E. Murphy, Secy.-Treas. and Gen. Mgr., is having preliminary plans prepared for 12 miles of pipe line also compressor station. Estimated cost $100,000.

Kan., Fort Riley—L. F. Felio, Constructing Quartermaster, awarded contract for the construction of a hangar, 1 story, 120 x 243 ft., two annexes each 22 x 40 ft. and boiler house annex 21 x 44 ft. to Harman Engineering Co., 844 North Rush St., Chicago, Ill. $53,707.

Mass., Cambridge (Boston P. O.)—City will soon award contract for the construction of a filter plant and pumping station in connection with waterworks improvements at Fresh Pond. Estimated cost $100,000. Fuller & Everett, 25 West 43rd St., New York, N. Y., are engineers. Bids received Oct. 23.

Mass., Taunton — Commonwealth of Massachusetts, Dpt. of Mental Diseases, awarded contract for improvement to boiler plant, to Edge Moore Iron Co., 11 Beacon St., Boston. Estimated total cost $45,000. Stoker, Chimney, etc. not awarded.

Mass., Westboro — Commonwealth of Massachusetts, Dept. of Mental Diseases, plans improvements to power plant including new equipment at State Hospital. Estimated cost $25,000. Private plans.

Mass., Williamstown—Williams College, Main St., awarded contract for the construction of a 1 story power plant to T. J. Glass Co., 124 High St., Greenfield. Estimated cost $45,000.

Mo., Maysville—City will soon award contract for waterworks improvements including well, filter and pumping plant, impounding reservoir, four motor driven pumps, filter units, etc. W. B. Rollins & Co., 339 Railway Exchange Bldg., Kansas City, are engineers.

Mo., Springfield—Treasury Dept., Office of Supervising Architects, Washington, D. C., will receive bids until Nov. 12 for construction of a group of buildings to include main building, acute building, continued treatment building, laundry, boiler house, general medical building, etc., at Hospital for Mental Delinquents here.

Neb., Grand Island—City awarded contract for a 2 story, 45 x 140 ft. addition to waterworks and power plant building to Paul Sothman, 1115 West Koenig, Grand Island. $11,602.

N. Y., Albany — Albany Port District Commission, c/o P. G. Ten Eyck, Chn., awarded contract for the construction of a grain elevator, 2,000,000 bu. capacity to Stewart Corp., 343 South Dearborn St., Chicago. $1,497,235.

N. Y. Albion—Dept. of Correction, State Office Bldg., Albany, will receive bids until Nov. 17, for refrigeration work, industrial building and storehouse at Institution for Mentally Defective Women here.

N. Y., Brooklyn — Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until Dec. 2, for construction, heating, sanitary and electric work for patients building, employees and staff accommodations, garage, power plant equipment and service connections, etc., also until Nov. 18, for buildings, 12, 19, 20, 21 and 22 and additional and service connections (tunnels) at Brooklyn State Hospital (Creedmoor Division) here.

N. Y., Corkaway—George Bruning, 178-15 93rd Ave., Queens Village, plans the construction of a 73 x 148 ft. ice manufacturing plant at Rockaway Blvd. and 234th St. Estimated cost $50,000. Private plans.

N. Y., Dannemora—Dept. of Correction, State Office Bldg., Albany, will receive bids until Nov. 24, for refrigeration work for Tuberculosis Hospital, Clinton Prison here.

N. Y., Ogdensburg—Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until Nov. 24, for refrigeration work at St. Lawrence State Hospital here.

N. Y., Ossining—Dept. of Correction, State Office Bldg., Albany, will receive bids until Dec. 10, for power house, tunnels, heating and electric connections and apparatus at Sing Sing Prison, here.

N. Y., Thiells—Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until Nov. 18, for refrigeration work, morgue and equipment, hospital building, refrigeration equipment, storehouse, etc. for Letchworth Village here.

Okla., El Reno—Bureau of Federal Prisons, Washington, D. C., is having plans prepared for a group of buildings including staff apartment house, power house, laundry and shops building, dormitories, warden residence and medical staff residence, etc. at Federal Reformatory here. Estimated total cost $643,000. James A. Wetmore, Washington, D. C. Acting Supervising Architect and Hawk & Parr, 1019 Hales Bldg., Oklahoma City, architects.

Okla., Pryor—City defeated $100,000 bond election for construction of a municipal power plant. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Tex., San Antonio — City is having preliminary plans prepared for a sewage treatment plant including sludge drier, grinder, conveyors, etc. Estimated cost $65,000. I. Ewing, is city engineer. Wants quotations on conveyors.

Tex., Sulphur Springs—City, c/o S. Gafford, Mayor and W. Buchanan, Secy., will receive bids until Nov. 3, for the construction of an electric generating plant and electric distribution system.

Equipment Wanted

Air Compressor — East Weymouth, Mass. — Plymouth Quarries Inc., plans to purchase a 600-1,000 ft. Ingersoll-Rand electrically driven air compressor.

Circuit Breakers—Wellington, N. Z.—Ministry of Public Works, will receive bids until Dec. 15, for supply 50,000 v. oil immersed circuit breakers.

Electrical Equipment—Chicago, Ill.—U. S. Engineers Office, War Dept., Washington, D. C., will receive bids until Nov. 16, for electrical equipment for Lockport, Marseilles and Starved Rock locks on Illinois Waterway.

Engines, Switchboard, etc.—Glidden, Ia.—Town Council, E. Mereness, Clk., will receive bids until Nov. 10 for two 15 hp. Diesel engines, direct connected to 100 kva., 3 ph., 60 cycle 2300 v. a.c. generators with direct connected exciters and auxiliary equipment; one five panel switchboard, consisting of two generator panels, two feeder panels and one street lighting panel, etc., for proposed Diesel engine electric generating plant.

Fans, Motors, Etc.—Roston, Mass.—Transit Dept., 1 Beacon St., will receive bids until Nov. 3, for equipment for Boston and East Boston Ventilation buildings, traffic tunnel, furnishing and installing fans with motors for each, or furnishing and installing ventilating fans or furnishing and delivering motors.

Generating Units—Philadelphia, Pa., and Norfolk, Va.—Bureau of Supplies and Accounts, Navy Dept., Washington, D. C., will receive bids until Nov. 3, for turbine driven generating units, condensers, air ejectors, etc., for Navy Yards at Philadelphia and Norfolk. Sched. 6719.

Pumping Equipment—Carlisle, Pa.—City plans to purchase pumping equipment, etc., for proposed waterworks improvements. Estimated cost $50,000.

Pump—Denver, Colo.—Garden Farm Dairy, P. O. Box 363, plans to purchase a 300 g.p.m. centrifugal or turbine pump with 220 v. motor, 90 lb. pressure.

Pumping Equipment—Guthrie Center, Ia.—City plans to purchase pumping equipment in connection with waterworks improvements. Estimated cost $35,000.

Industrial Projects

Conn., Meriden—International Silver Co., J. A. Hutchinson, 48 State St., awarded contract for alterations to buildings 1 and 2, Factory E. to Bartlett-Brainard Co., 252 Asylum St., Hartford.

Ga., Savannah—Evans Products Co. Inc., Union Guardian Bldg., Detroit, Mich., awarded contract for a 1 story factory for the manufacture of automobile loading equipment, etc., here to Artley Co., 504 East Bay St., Savannah. Estimated cost $45,000.

Mass., Whitman—United Shank & Findings Co., c/o United Shoe Machinery Corp., 140 Federal St., Boston, awarded contract for a 2 story addition to factory to Casper-Ranger Construction Co., 6 Newton St., Holyoke. Estimated cost $40,000.

N. J., Edgewater—Lever Bros., 371 7th Ave., New York, N. Y., will soon award contract for the construction of a soap manufacturing plant including boiler house, etc. on River Road. Estimated cost $40,000. Stone & Webster, 49 Federal St., Boston, Mass., are architects and engineers.

N. Y., Fort Edward—Amalgamated Paper Co., will soon award contract for a 1 story, 50 x 150 ft. factory for the manufacture of writing paper and other paper stocks. Estimated cost $60,000.

N. Y., New York—Atlas Organ Co., 726 Jackson Ave., lessee, will award contract about Nov. 15 for the construction of a 2 story, 44 x 103 ft. pipe organ manufacturing plant at 239th St. and Bullard Ave., for Paul Sowada, 369 Palmer Ave., Yonkers. Estimated cost to exceed $40,000.

N. C., Canton—Champion Fibre Co., R. B. Robertson, Pres., plans to expend $1,000,000 for expansion program to include three large buildings. Machinery and equipment to cost $500,000 will be installed.

N. C., Marble—Columbia Marble Co., 303 Scottish Park, Knoxville, Tenn., plans the construction of a marble finishing plant here. Estimated cost $125,000.

Okla., Oklahoma City—Vitric Products Co., 215 Commerce Exchange, plans completed for a glass products plant. Estimated cost $200,000. F. W. Fenten, 215 Commerce Exchange, is engineer.

Wis., Sheboygan—Hayssen Mfg. Co., manufacturers of bread-wrapping machinery, plans completed for a 2 story addition to factory including boiler room. W. C. Weeks Inc., Sheboygan, are architects.